PROPOSED EXPANSION OF MINING AND RECLAMATION PLAN,

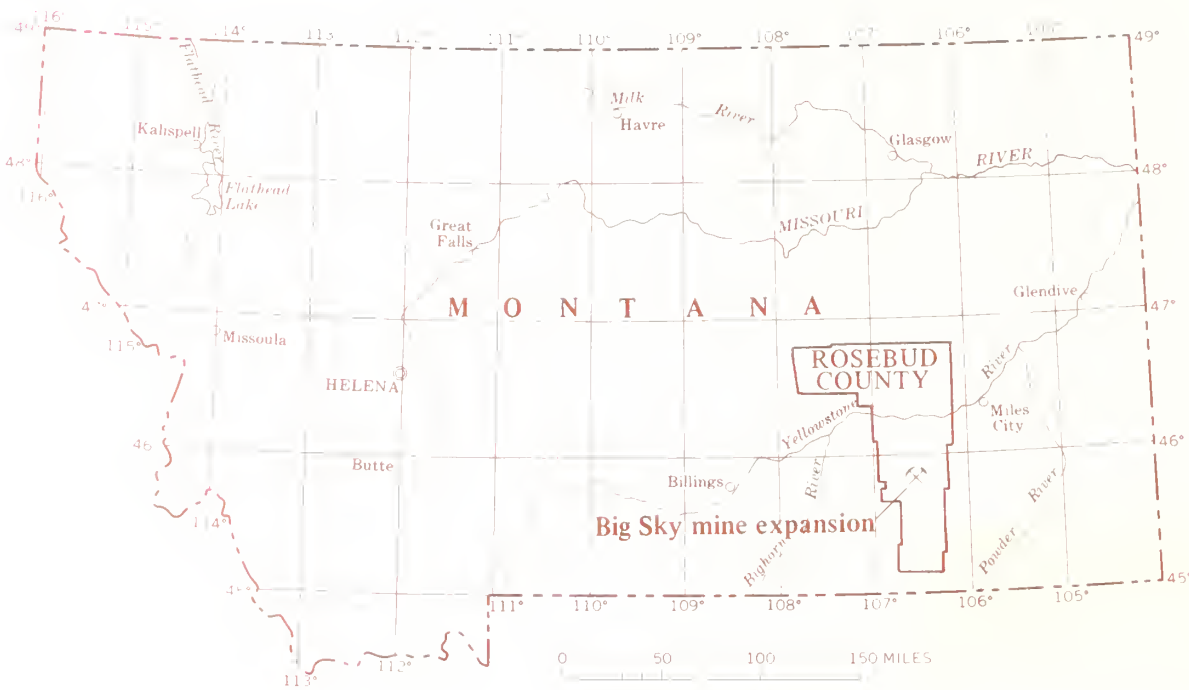
BIG SKY MINE,

ROSEBUD COUNTY, MONTANA

THE GREAT SEAL OF THE STATE OF MONTANA
ORO Y PLATA

DRAFT ENVIRONMENTAL STATEMENT

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849


MONTANA
ROSEBUD COUNTY
Big Sky mine expansion
Kalispell
Flathead Lake
Havre
Milk River
Glasgow
MISSOURI RIVER
Great Falls
Glendive
Missoula
HELENA
Butte
Billings
Yellowstone River
Bighorn River
Miles City
Powder River
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United States Department of the Interior

GEOLOGICAL SURVEY

Enclosed for your review and comment is a copy of the draft environmental impact statement prepared by the U.S. Geological Survey, in cooperation with the State of Montana, on the proposed surface coal mining operation by the Peabody Coal Company at the Big Sky mine in Rosebud County, Montana. This statement, DES 78-51, was transmitted to the Environmental Protection Agency on December 14, 1978.

The Director, U.S. Geological Survey, National Center, Mail Stop 108, Reston, Viriginia 22092, will receive any written comments you may wish to make on this impact statement until the close of business on February 5, 1979. All comments received by that date will be carefully considered in our preparation of the final statement.

Additionally, you may address any questions concerning the statement to [illegible] Montana [illegible] or the Commissioner of [illegible] Helena, Montana 59601.

PLEASE NOTE: In the interest of reducing printing costs for reproducing environmental impact statements, all or parts of the proposed Big Sky mine expansion draft statement may be incorporated by reference into the final statement. If no major changes in the draft are necessary, a printed supplement addressing relevant comments will be substituted for a totally reprinted final statement, and mailed to all interested parties. Please keep the draft text and maps against that possibility.

U.S. DEPARTMENT OF THE INTERIOR
MONTANA DEPARTMENT OF STATE LANDS

DRAFT
ENVIRONMENTAL STATEMENT

PROPOSED EXPANSION OF MINING AND RECLAMATION PLAN
BIG SKY MINE

PEABODY COAL COMPANY
ROSEBUD COUNTY, MONTANA

FEDERAL LEASE M-15965

Prepared by
U.S. Geological Survey, Department of the Interior
Montana Department of State Lands

Leo Berry, Jr., Commissioner
Montana Department of State Lands

H. William Menard, Director
U.S. Geological Survey

1978

SUMMARY

BIG SKY MINE EXPANSION

(X) Draft ( ) Final Environmental Statement

Department of the Interior, U.S. Geological Survey

Montana Department of State Lands

1. Type of action: (X) Administrative ( ) Legislative

2. Brief description of action:

State and Federal actions involve either approval or denial of permits for the reclamation plans, Big Sky mine, Peabody Coal Co., Rosebud County, Montana. The company proposes to expand the existing plant and loading facilities, haul and access roads, and the existing rail spur extending from Colstrip would be utilized. An estimated 30 million tons of low-sulfur coal would be removed from an area of about 894 acres over a period of about 8 years.

3. Summary of adverse, unavoidable environmental impacts:

A. Vegetation, soil, and overburden would be removed from 894 acres.

B. It is uncertain that former vegetative productivity levels can be reestablished. There would be a loss in vegetative diversity for possibly several decades.

C. Existing local aquifers would be destroyed; the returned spoils, where saturated, would contain water of poor quality unsuitable for domestic or livestock use.

D. Wildlife habitat would be altered and wildlife diversity would be reduced. Livestock forage may be increased upon reclamation.

E. Unless best available control technology were applied during mining significant dust emissions would increase approximately 100 percent, to 5,445 tons per year, and gaseous emissions would increase 50 percent to 696 tons per year. These would exceed air quality standards. Visibility would be decreased. Under best available control techniques, the amount of fugitive dust would be reduced by 74 percent.

F. A minor increase in population would occur in the area during mining; increased commuter traffic would be caused by 32 additional employees.

G. 1,264 acres of land would be temporarily removed from range, recreation, and wildlife uses during mining and reclamation.

H. There may be an increase in surface water runoff, and a reduction in both surface and ground water quality.

I. Thirty-four cultural resource sites would be disturbed or destroyed on the 1,264 acre permit area.

J. Doubling of train traffic on the 7.5 mile rail spur would increase the hazard of train/vehicle and train/livestock collisions, increase delay at rail crossings, and increase pollution and noise along the right of way.

4. Alternatives considered:

Administrative alternatives available to State and Federal agencies include: (a) deferring action, (b) preventing further development by suspending operations, cancelling the lease, or acquiring the lease, (c) rejecting the mine and reclamation plan or restricting development on the lease. Other options available include development of selected areas now under lease and approval of the proposed mining plan after modification. The mining and reclamation plan must be modified to meet criteria set forth in the Surface Mining Control and Reclamation Act of 1977 and the Strip and Underground Mine Reclamation Act of 1973 and other pertinent criteria. Agencies may also add stipulations to the permit which would minimize the environmental impacts by imposing various technical alternatives. The major stipulations to be considered include: the use of best available control technology for all mine dust and gaseous emissions, implementation of a monitoring system for ambient air, double-lift salvage of topsoil, selective salvage and replacement of soils to better simulate premining conditions, reduction of slope lengths to minimize erosion, eliminating major surface depressions and redesigning diversion channels for higher intensity storms.

SUMMARY ATTACHMENT I

Comments are being requested from the following:

Federal agencies:

Department of Agriculture
  Forest Service
  Soil Conservation Service
Department of Commerce
  Old West Regional Commission
Department of Energy
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
  Bureau of Indian Affairs
  Bureau of Land Management
  Bureau of Mines
  Bureau of Reclamation
  Fish and Wildlife Service
  Heritage Conservation and Recreation Service
  Office of Surface Mining
Department of Labor
  Mining Safety and Health Administration
Department of Transportation
Environmental Protection Agency
Federal Energy Regulatory Commission
Interstate Commerce Commission
President's Advisory Council on Historic Preservation

State and local agencies:

Office of the Governor, Montana
Office of the Governor, Wyoming
Montana Agricultural Experiment Station
Montana Department of Community Affairs
Montana Department of Revenue
Montana Energy Advisory Council
Montana Environmental Quality Council
Montana State Historic Preservation Officer
Montana Department of Fish and Game
Montana Department of Health and Environmental Sciences
Montana Bureau of Mines and Geology
Montana Department of Natural Resources and Conservation
Board of County Commissioners, Big Horn County, Montana
Board of County Commissioners, Rosebud County, Montana
Board of County Commissioners, Sheridan County, Wyoming
Mayor, City of Sheridan

Summary Attachment I--Continued

<u>Tribal councils</u>:

Northern Cheyenne

<u>Applicant</u>:

Peabody Coal Company

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CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

THIS CHAPTER IS A DETAILED DESCRIPTION OF PEABODY COAL COMPANY'S PROPOSAL TO MINE AND RECLAIM FEDERAL AND NON-FEDERAL COAL LANDS IN ROSEBUD COUNTY, MONTANA. ACTIONS REQUIRED BY THE STATE AND FEDERAL AUTHORITY ARE ALSO INCLUDED IN CHAPTER I.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTIONS

A. INTRODUCTION

Peabody Coal Company's Big Sky mine is located in south-central Rosebud County, Montana, approximately 5 miles south of Colstrip and Western Energy's Rosebud mine. The Northern Cheyenne Indian Reservation lies 10 miles to the south (fig. I-1). Peabody has a long-term contract to supply this coal to the Minnesota Power and Light Company at Cohasset, Minnesota.

The coal company proposes to expand its existing operation from 2.3 mty (million tons per year) to 4.2 mty by 1981 and would mine about 30 million tons of coal by 1985. About 82 acres of coal would be mined each year, an anticipated 168 acres of surface being disturbed at any one time. This 7-year plan is an expansion of existing operations, and it is anticipated that 32 employees would be added to the existing work force. The present application to the State of Montana covers 5 years (1978-82).

In April 1976 the Secretary of the Department of the Interior directed that a regional impact statement covering proposed development on existing Federal coal leases in the Montana portion of the Powder River Basin be prepared. This includes parts of Custer, Rosebud, Treasure, Big Horn, and Powder River Counties. This document is closely correlated with the forthcoming Northern Powder River Basin regional environmental impact statement, in that it is one of several proposals considered in that document.

B. FEDERAL, STATE AND COUNTY ACTIONS

Several interrelated Federal, State, and county actions are involved in the approval or denial of applications for permits, stemming from Peabody Coal Co.'s proposal. Federal and State surface mining and reclamation permits must be obtained, in addition to permits required for associated activities. Peabody Coal Co.'s existing mine already has many of those permits which would be required for the opening of a new mine; thus, only those permits listed below will be required for this expansion.

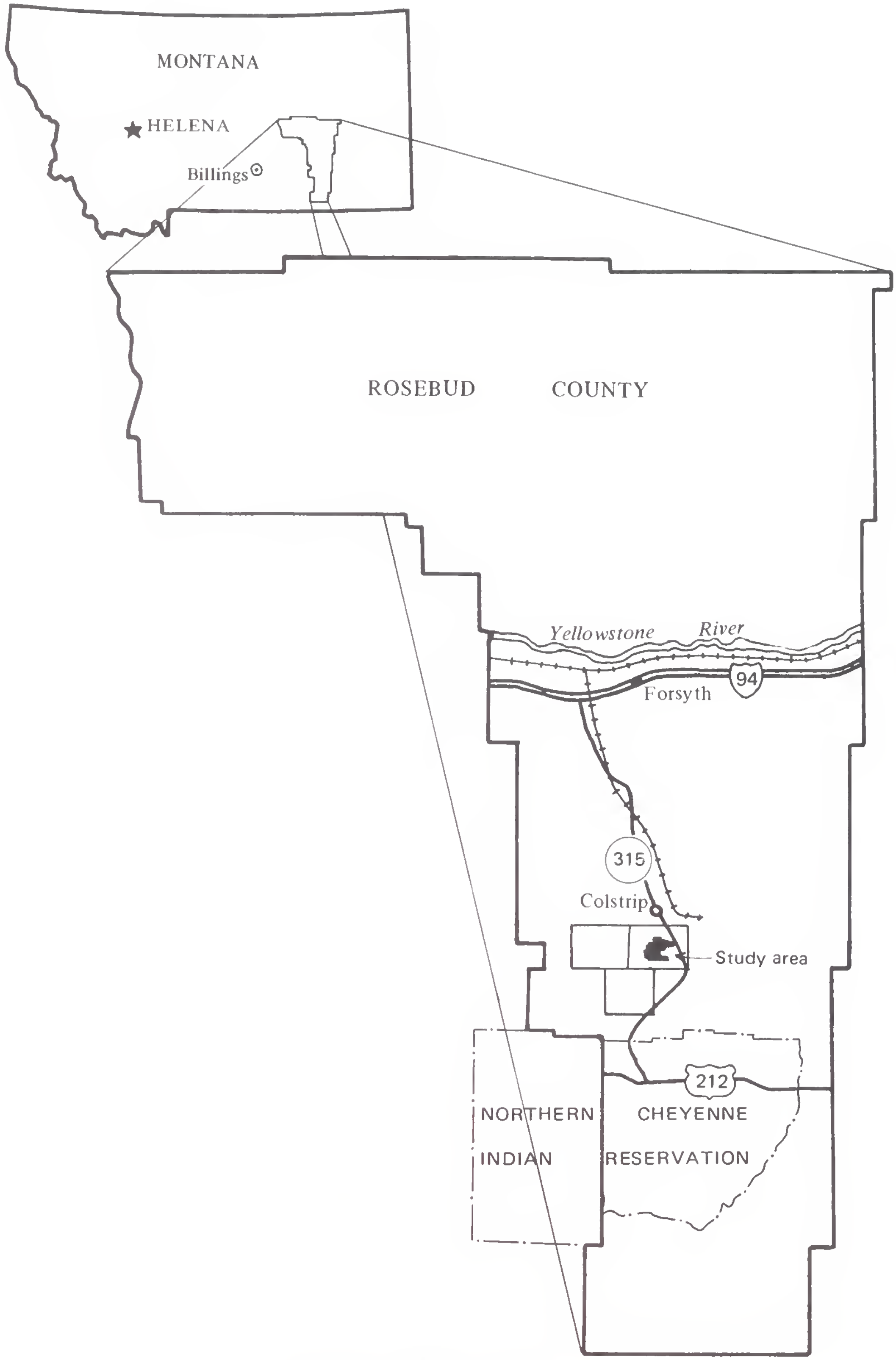

Figure I-1.—Index map.

Permit	Agency
1. Surface mining and reclamation[1]	Office of Surface Mining U.S. Geological Survey Montana Department of State Lands
2. Streambed construction and runoff retention	Army Corps of Engineers Montana Department of Health and Environmental Sciences Montana Department of Natural Resources and Conservation Rosebud Conservation District
3. Air quality emissions	Environmental Protection Agency Montana Department of Health and Environmental Sciences

A number of the coal-related actions in Montana are simultaneously pending before both Federal and State agencies, and the requirements of the Montana Environmental Policy Act (MEPA) are essentially the same as those of the National Environmental Policy Act (NEPA). Because of this, the Montana Department of State Lands and the U.S. Geological Survey agreed in 1976 to prepare a joint regional environmental statement to meet their individual responsibilities in a single effort. That regional statement is expected to be published in draft form in early 1979.

The regional statement analyzes several possible future levels of coal development; it takes into account presently approved mining operations, a number of pending proposed mines, and development of existing sources of coal. In addition, the regional statement includes actions on pending lease applications for Federal coal, to the extent that the Secretary of the Interior is permitted to do so under judgements rendered in the case of NRDC vs. Hughes (Civil Action No. 75-1749, U.S. District Court for the District of Columbia). The regional statement includes an evaluation of the cumulative impacts that would be generated by all the pending mining operations and other developments that may occur by 1990. Cumulative impacts are covered to the extent necessary in this site-specific statement.

The application for the Big Sky mine expansion was submitted in November 1977. In order to comply with MEPA and NEPA requirements, State and Federal agencies have cooperatively written this site-specific analysis. In order to accommodate Peabody Coal Co., who is running out of permitted coal in late 1978, this site-specific statement was written separately from the regional EIS.

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[1]Office of Surface Mining and Department of State Lands permit include all three permit items in this list.

The mining and reclamation plans described in this statement were prepared on the basis of information and maps furnished by Peabody Coal Co. to the U.S. Geological Survey and the Montana Department of State Lands. The proposed plans must comply with pertinent Federal, State, and county laws for Peabody Coal Co. to be permitted its extension of present mining operations.

The mining and reclamation plan discussed in this statement was submitted for review prior to the promulgation of initial regulations (30 CFR 700) required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (Public Law 95-87) and the emergency regulations promulgated under the Montana Strip and Underground Mine Reclamation Act of 1973 (Title 50, Chapter 10, RCM 1947). The company's mining and reclamation plan has been reviewed for compliance and does not reflect the initial requirements of these regulations (appendix P). However, in this statement the regulations are considered to be required Federal and State mitigating measures.

The mining and reclamation plan has been returned to the operator with a request that it be revised in accordance with the applicable regulations. In response to this request, the company is preparing a modification of the mine plan. As soon as the mining and reclamation plan is officially revised and submitted to the Office of Surface Mining, the U.S. Geological Survey and the Montana Department of State Lands, it will be evaluated to determine its compliance with Federal and State regulations.[2]

C. BACKGROUND AND HISTORY

The Big Sky mine was opened by the Peabody Coal Co. in 1969 in sec. 27, T. 1 N., R. 41 E., Montana Principal Meridian, Rosebud County, to mine coal leased from the Burlington Northern Railroad.

Following a competitive sale, Federal coal lease M-15965, containing 4,306.55 acres, was issued to Peabody Coal Co. on April 1, 1971. In 1974 an EIS was prepared by the U.S. Geological Survey in cooperation with other Federal agencies.[3] The proposed action was to mine in sec. 22, T. 1 N., R. 41 E. (fig. I-6); however, the entire leasehold was discussed. Figures I-1 and I-2 show the location of the entire lease, although the company's present application for State and Federal mining permits includes acreage only in area "A." Permit applications will be filed for areas "B" and "C" in the future, starting in area "B" in about

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[2]See letter (appendix P) to Peabody Coal Co. from the Montana Department of State Lands.

[3]U.S. Geological Survey, 1974, Proposed plan of mining and reclamation, Big Sky mine, Peabody Coal Company, Federal coal lease M-15965, Colstrip, Montana: Final Environmental Statement FES 74-12.

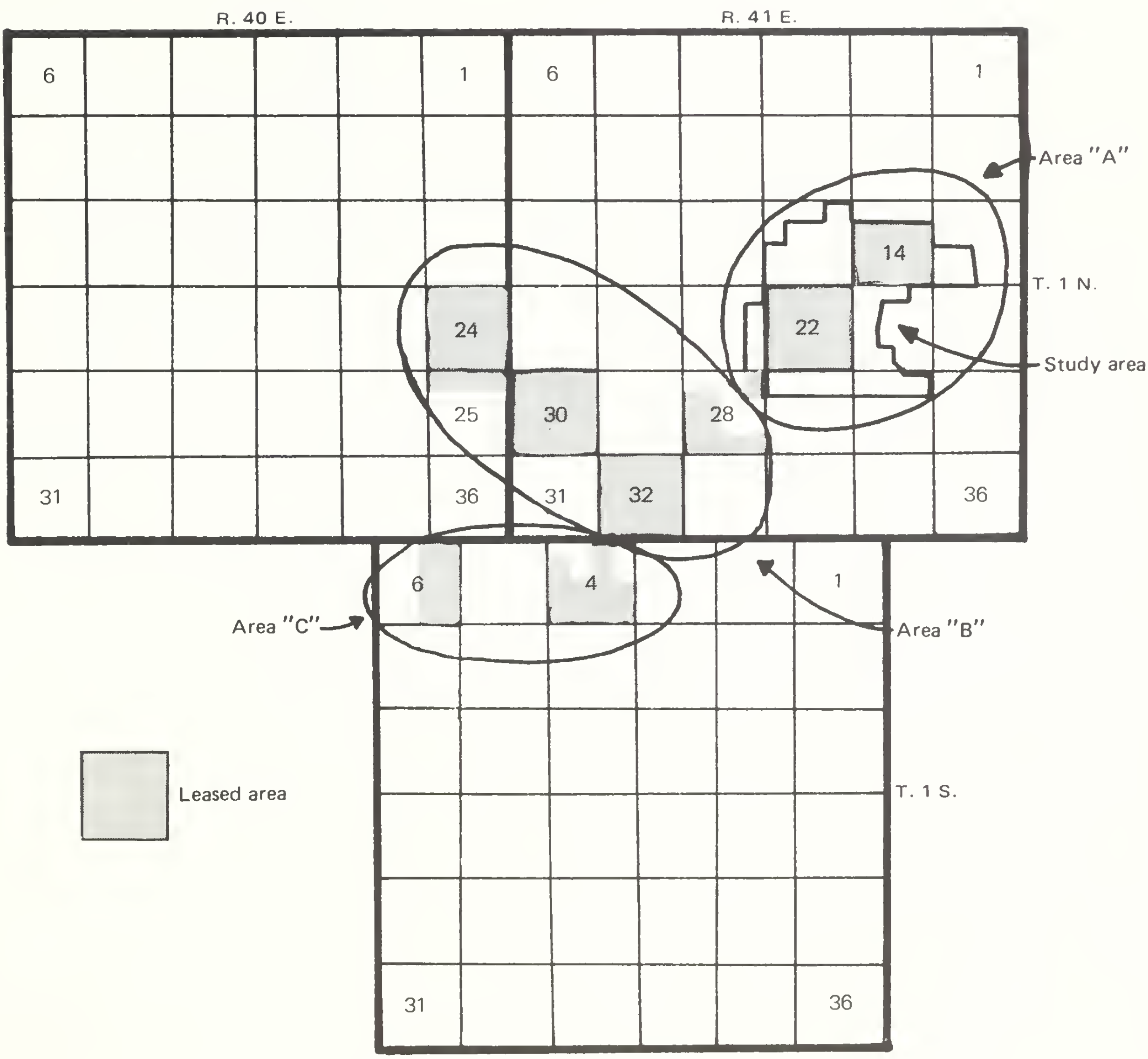

Figure I-2.—Lease areas at the Big Sky mine (Federal lease M15965) Present mining activity is entirely within area A.

1983. It is assumed that future permit applications will require additional environmental statements. Mining is currently being conducted in sec. 22, T. 1 N., R. 41 E., but the entire operation, including facilities, consists of 1,079 acres.

The Federal lease with the Bureau of Land Management is a continuing lease, subject to readjustment on a 20-year basis. The lessor may prescribe restoration and improvements to be made on leased lands. In addition, the lease contains five general requirements and five special stipulations covering surface reclamation and protection of the environment.

This site specific analysis covers an area of approximately 2,600 acres (area A). Of the 2,600-acre mine area, about 1,264 acres is included in the present permit application; 894 acres would be subject to actual mining level disturbance. Surface ownership is held by Peabody Coal Co. (1,120 acres), Burlington Northern Railroad Co. (1,320 acres), and the Federal Government (160 acres) (fig. I-3). Mineral ownership in this area is held by the Burlington Northern Railroad and the Federal Government (fig. I-4). Part of area "A" is included in oil and gas lease M-29725 (fig. I-5), but no drilling is anticipated during the permit period. The two tracts of Federal coal in the study area contain 840 acres, of which 377 acres is included in the new permit application. The two previous mine permits included 352 acres.

The yearly production at the Big Sky mine has been as follows:

Year	Short tons	Year	Short tons
1969----	163,769	1974----	2,228,525
1970----	1,437,955	1975----	2,194,925
1971----	1,495,043	1976----	2,407,000
1972----	1,601,108	1977----	2,312,329
1973----	1,971,643	Total--	13,663,737

Three levels of land disturbance identified in this application extend over 1,263.63 acres. Table I-1 explains these levels. The new permit area overlaps the previously permitted areas because some areas previously permitted for associated disturbance are now planned to be mined.

D. COAL RESOURCES

The subbituminous coal deposits at Big Sky are in the Tongue River Member of the Fort Union Formation. Peabody proposes to expose and mine the Rosebud and the McKay coal seams. The Rosebud, the uppermost of the two seams, is 25-30 feet thick in this area and is the most valuable coal in central Rosebud County. Its Btu (British thermal unit) value per pound (dry) ranges from approximately 11,200 to 11,780 with an average sulfur content of 1.1 percent. The McKay seam is separated from

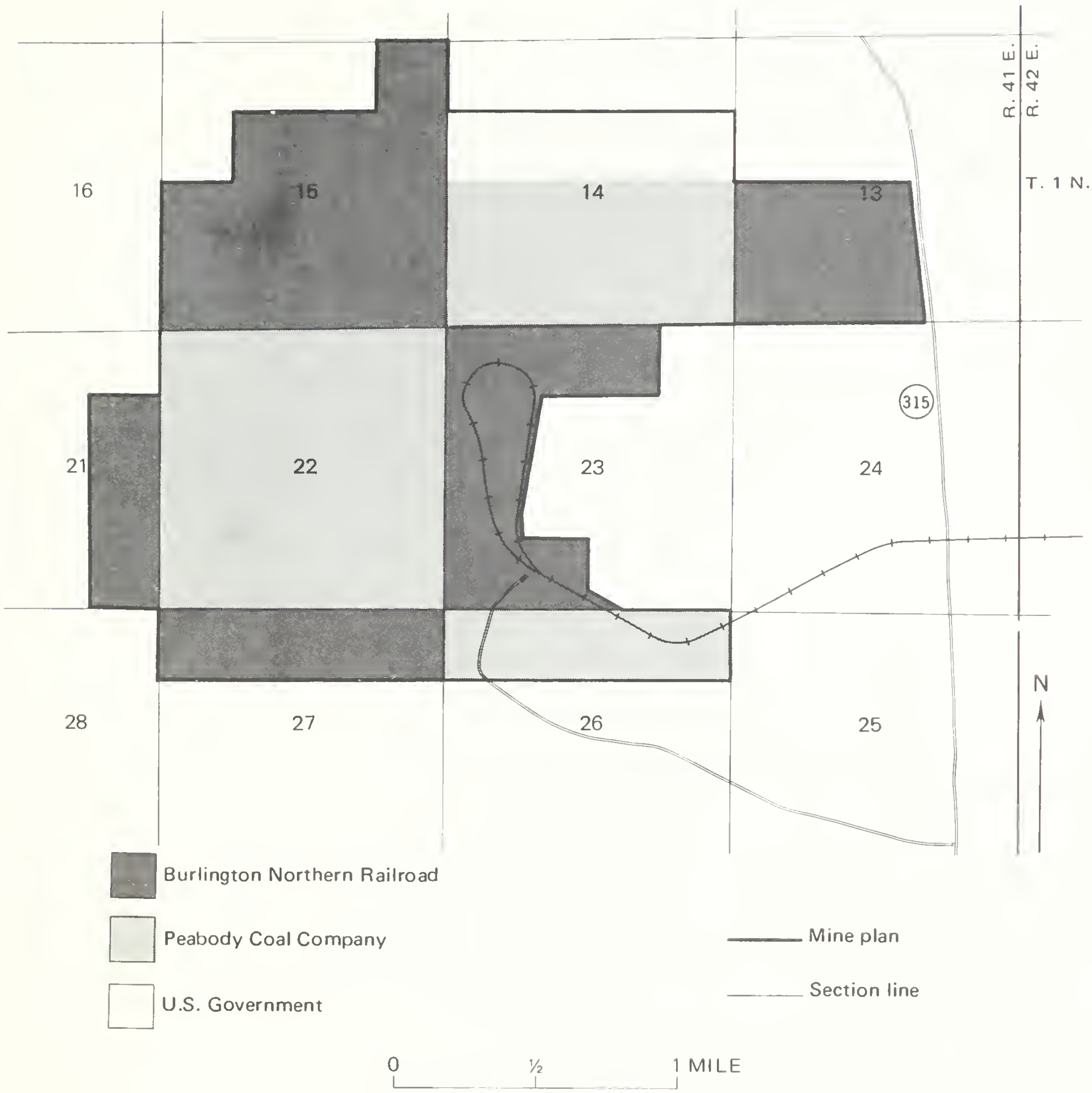

Figure I-3.—Surface ownership.

Figure I–4.—Mineral ownership.

Figure I–5.—Mineral leases.

TABLE I-1.--Acreages in the 1978 permit application area

Acreage breakdown for 1978 permit application area

	Acres
1. Mining level (pit, spoils, topsoil salvage area, ramp roads, scoria pit, etc.):	
To be mined-------------------------	584.17
Scoria pit--------------------------	58.08
Total-------------------------	642.25
Area previously bonded as associated disturbance (75004-A001) and now being bonded as mining level--------------------	251.31
Total mining level in 1978 permit application---------	893.56
2. Facilities (structures, roads, railroad loops or spurs, settling or treatment facilities, loadout and storage facilities, etc. that are more or less permanent through the life of the mine.)--------------------	12.42
Area previously bonded as associated disturbance (73004-A001, 75004-A001) and now being bonded as facilities------------	15.15
Total facilities level in 1978 permit application----	27.57
3. Associated Disturbance (used for miscellaneous minor disturbances such as powerlines to equipment, portable substations, topsoil stockpiles, diversion ditches, small detention or diversion dams and impoundments, etc.):	
Total associated disturbance level in 1978 permit application---------------------	342.50
Total acreages in 1978 permit application area-----------	1,263.63

the Rosebud by 6-35 feet of shale, sandy shale, and sandstone. Coal in this seam is commonly 6-8 feet thick. Selected analyses of coal from the McKay seam indicate 10,000 to 11,900 Btu's per pound (dry) with an average of 1.97 percent sulfur.[4]

The Robinson seam, 8 feet thick, occurs 130 feet below the McKay and is considered to be uneconomical to recover.

The company proposes to mine parts of the following tracts over an 7-year period, (1978-85) as shown in figure I-6.

T. 1 N., R. 41 E.,	section 13:	SW1/4, W1/2SE1/4
	section 14:	S1/2N1/2, S1/2
	section 15:	SE1/4NE1/4, E1/2SW1/4, SE1/4
	section 22:	NE1/4NW1/4, W1/2NE1/4, W1/2SW1/4
	section 23:	NW1/4NE1/4, NE1/4NW1/4

Coal reserves, approximately half of which are Federal, would be mined at the following rates:

	Million tons per year
1979----------	2.3
1980----------	3.0
1981-85----------	4.2

It is anticipated that 168 acres would be ungraded and unseeded at any one time.

E. PREMINING PLANNING AND ACTIVITY

1. Water Diversion and Impoundment

The extension of the Peabody Big Sky mine would intersect Emile (Coal Bank) Coulee (fig. I-7), on which a large dam would be built in the NE1/4NW1/4 of sec. 23 for sediment control. Plans for the construction of this dam are shown in figure I-8. Special measures or a change in design will be required for establishment of vegetative cover because of the steepness of the slopes.

At no time would runoff be allowed to drain into the mining area. The company proposes to establish diversion ditches or dikes along the high side of the mine pit. These structures, designed to accommodate a 10-year, 24-hour peak flow, would divert surface runoff from the pit into settling basins. Suspended material would settle, and the overflow would be directed into natural stream channels below the mine. All

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[4]On an "as received basis," the Btu of Rosebud coal from sec. 22 averages about 8,535; the McKay coal averages about 8,585 (U.S. Geological Survey, 1974, Final Environmental Statement FES 74-12, p. 70).

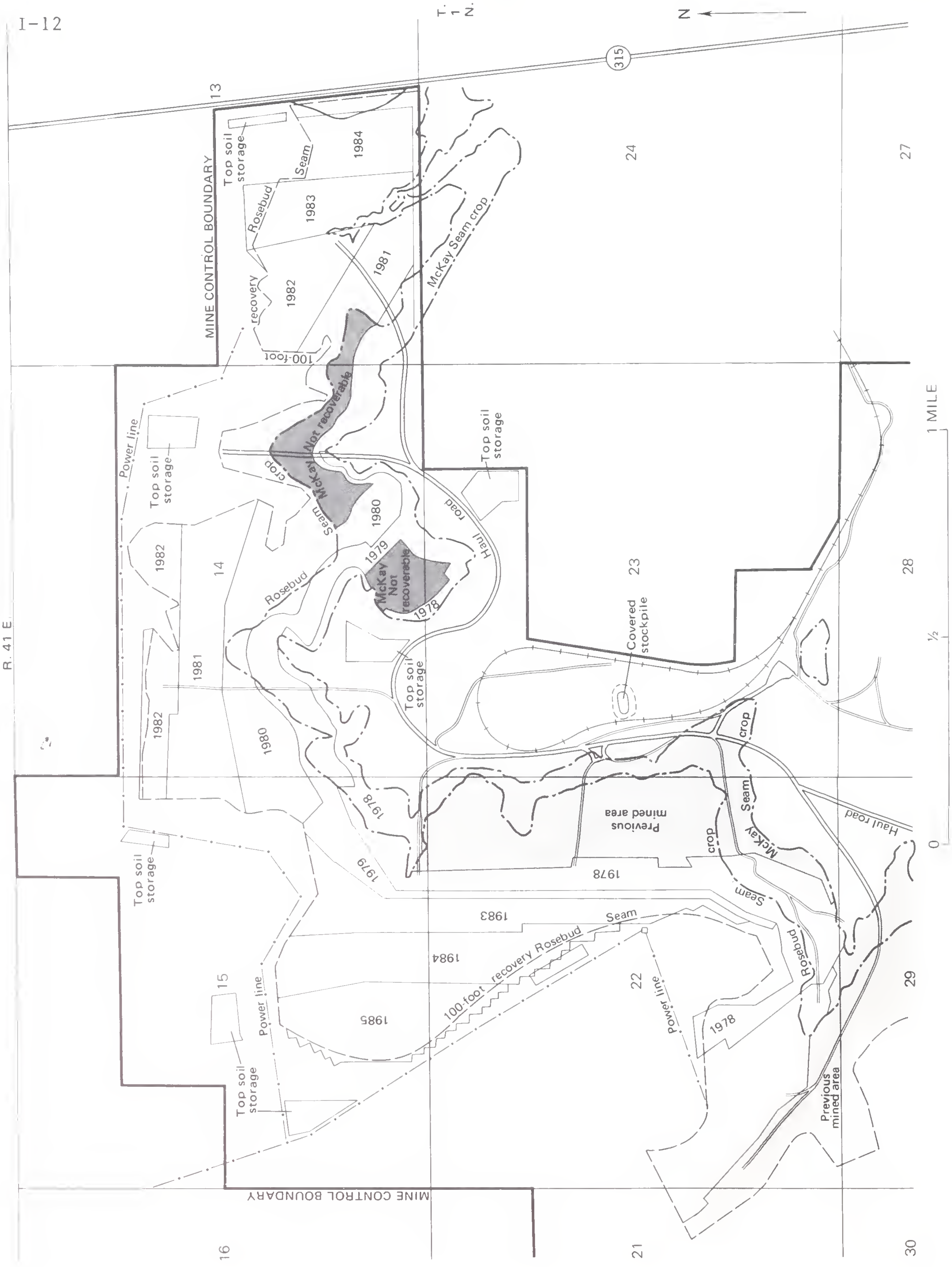

Figure I–6.—Mining sequence map.

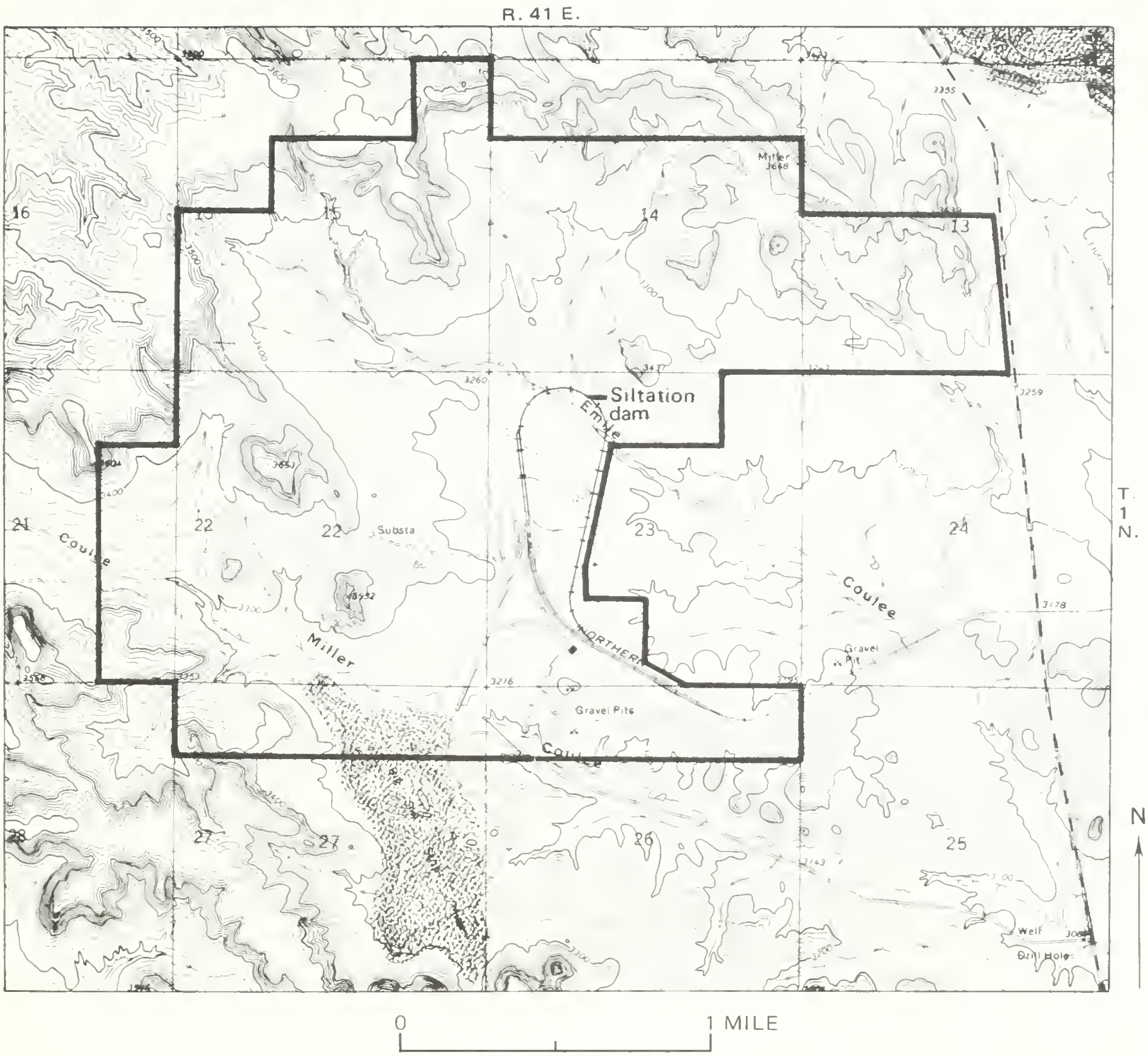

Figure I-7.—Permit area topography. Stipple pattern indicates old mine spoils.

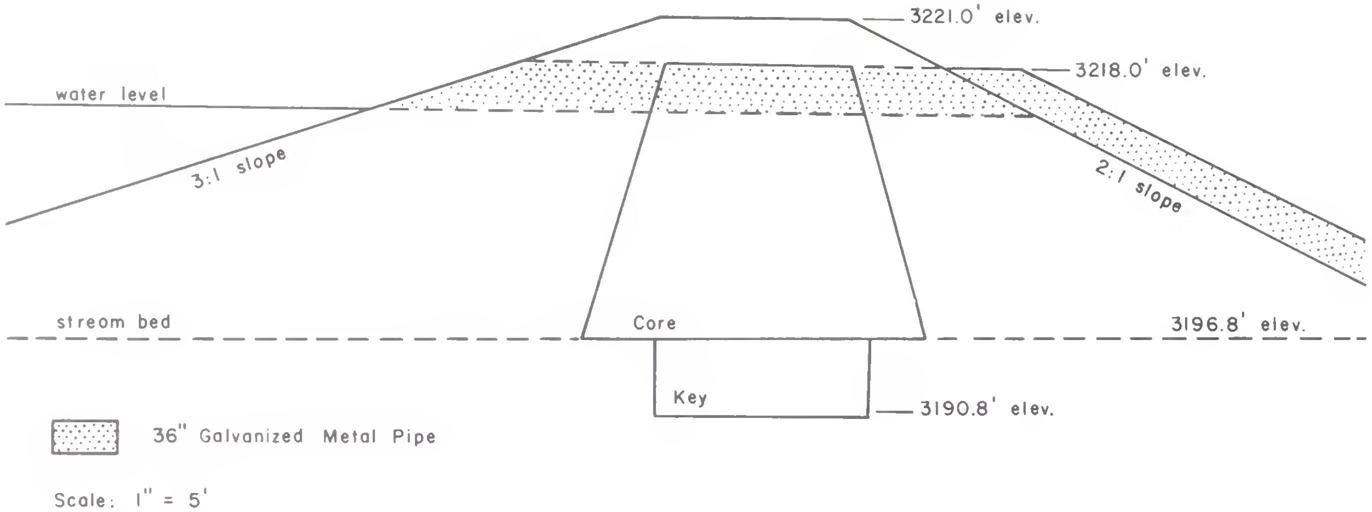

Figure I-8.—Cross-section of proposed siltation dam on Emile Coulee (SW¼NE¼NW¼ sec. 23, T.1N., R.41E.), Big Sky mine, Montana.

diversion-ditch banks and impoundment-dam banks would have vegetative cover to control erosion.

Ground water intercepted by the mining operation would be pumped out of the mine pit and used for dust suppression on haul roads and irrigation of reclaimed land. Excess would be diverted to settling ponds.

2. Surface Facilities

No new facilities would be built for this mine expansion. Existing facilities (fig. I-9) include:

1. A 2.3-mile access road to State Highway 315.

2. A 7.5-mile railroad spur to Colstrip.

3. Several steel-frame structures: an office, a maintenance shop, change rooms and bath facilities, and storage buildings.

4. Fuel and explosive storage (gasoline consumption is estimated to be 35,516 gallons per year and diesel fuel at 410,827 gallons per year). These are to be stored in fuel tanks within levees. Explosives are stored according to standards established by 26 CFR 181.

5. Coal facilities:

   a. Primary and secondary crushers with elevated conveyors.
   b. Storage silos.
   c. A tipple loadout with weighing and sampling stations.
   d. Water sprays for dust suppression.
   e. Coal transport unit trains (100 cars with 100-ton capacity each).

6. A 69-kV powerline from Colstrip.

7. Water and waste disposal system: wells provide water for domestic and sanitary use. A septic system with a 400-person capacity treats waste water. Water for dust suppression is from mine effluent, and, if necessary, from wells.

8. 2.05 miles of haul roads built to State and Federal specifications.

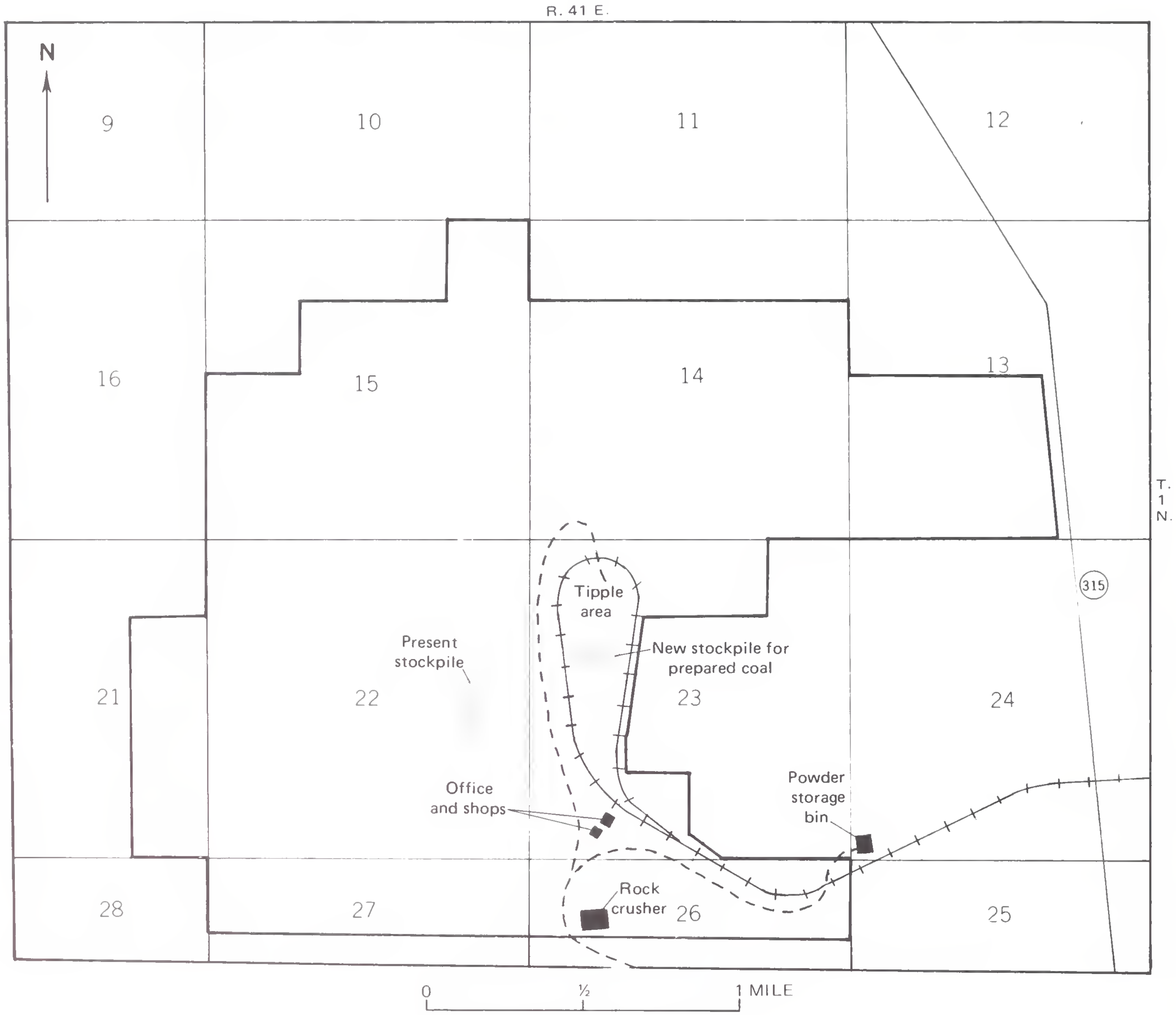

Figure I-9.—Location of facilities.

Facilities used in the mine expansion include:

1. Portable substations that provide power to the in-pit equipment.

2. Extension of haul roads.

3. Mining Sequence

The mining sequence would progress from the Miller Coulee area in sec. 22, T. 1 N., R. 41 E., staying in sec. 22 and working new pits adjacent to those previously mined (figs. I-6, I-7).

Peabody proposes to mine first that portion of the McKay coal seam that extends beyond the limit of occurrence of the Rosebud where the overburden is 100 feet or less deep. As mining progresses, a zone would be reached where both the Rosebud and McKay can be mined. When the overburden above the McKay reaches a depth of 100 feet, the company proposes to stop recovery of the McKay. However, they would continue mining the Rosebud until the overburden above it also reaches 100 feet. The company believes that it is uneconomical to recover the coal below 100 feet. To further simplify mining, the company proposes to mine in straight-line segments along the 100-foot overburden line. The Coal Conservation Act of 1973 and the 30 CFR 211 regulations of 1975 require that, for conservation purposes, the company must recover all the coal that can be recovered economically. The company may, therefore, be required to mine beyond the presently proposed limits.

When the mining limit has been reached, the final highwall would be reduced by backfilling to a slope of no greater than a 3:1 slope, although the Montana Department of State Lands may require a 5:1 slope. All disturbed areas would be graded to curtail erosion and would then be revegetated with predominantly native species.

F. MINING

1. Topsoil Removal

In order to begin mining activities, the company would remove topsoil materials[5] from all areas to be affected by construction, by removal of the overburden, or by placement of spoils. Whenever possible, topsoil material would be placed directly on regraded spoils, thus eliminating stockpiling. Where stockpiling is necessary, the topsoil would be located on sites outside the coal-bearing areas. The stockpiles

[5]"Topsoil materials" are defined as the oxidized and weathered material found within the root zone and capable of supporting plant growth under existing conditions.

would be revegetated with species approved by DSL (Department of State Lands) and OSM (Office of Surface Mining) to reduce erosion and to prevent invasion by undesirable vegetation.

2. Overburden Preparation and Removal

Overburden would be drilled and blasted to break up the consolidated material. Blast holes 10 inches in diameter would be drilled in a predetermined pattern. The amount of ammonium nitrate/fuel oil explosive placed in each hole would depend on the characteristics and configuration of the strata to be blasted and the spacing of adjacent holes. Primers would be exploded by detonating cord and, in turn, would detonate the mixture in each blast hole. Blasting procedures would be in keeping with all safety regulations.

The overburden would be removed and deposited in a previously mined area. The primary stripping machine would be a dragline with a 30-cubic-yard bucket, a 200-foot boom, and an operating radius of 190 feet. The secondary stripping machine would be a dragline, with a 14-cubic-yard bucket, a 175-foot boom, and a 165-foot operating radius.

3. Coal Drilling, Blasting, and Removal

Bulldozers would clean coal slack from the top of the coal bed and push it against the base of the newly deposited spoil bank, where it would be buried with spoils from the next cut.

Drilling and blasting would break up the coal seams. A rotary drill would be used to drill 6-inch holes on 25-foot centers to the base of the coal. Seventy-five pounds of ammonium nitrate/fuel oil explosive per hole would be used in the Rosebud bed and 25 pounds per hole in the thinner McKay bed. The blasting procedures would be similar to those used in overburden blasting.

The fractured coal would be loaded onto coal trucks and dumped at the storage area near the crushers and loading tipple.

G. RECLAMATION

Peabody Coal Co.'s reclamation proposals must comply with Federal and State regulations in order to be approved by the appropriate regulatory agencies.

1. Shaping of Overburden

The highwalls and spoils would be graded to a rolling topography, with slopes no greater than 3:1. The proposed final topography for

the reclaimed area (fig. I-10) contains a number of depressions ranging up to 10 acres in size. These may or may not be approved by the State and Federal permitting agencies. Peabody Coal Co. will also be required to better integrate the reclaimed drainage into the natural drainage of Emile Coulee.

When encountered, materials not conducive to revegetation would be buried to a minimum depth of 8 feet below the reclaimed surface.

2. Topsoil Redistribution and Seeding

Topsoil would be obtained from stockpiles or areas where it is being removed in preparation for mining. Scrapers would be used to redistribute the topsoil.

After the seedbed has been prepared, areas to be reclaimed would be seeded or planted (table I-2) during the first appropriate season, not to exceed 90 days from the initial preparation date. The seed mixture will be modified and approved by DSL (Department of State Lands) and BLM (Bureau of Land Management).

The topsoil would be disced, and seed would be distributed at a rate of 22 pounds per acre. Seeded areas would then be harrowed to bury the seed and to produce a cloddy, permeable, erosion-resistant surface texture. The use of fertilizer is not anticipated at this time; instead, the low nitrogen content of the topsoil would be enriched by planting nitrogen-fixing legumes, such as alfalfa and sweetclover. Trees and shrubs would be planted in groups to approximate those occurring naturally. Although Peabody Coal Co. does not propose to mulch, State and Federal agencies will require it.

3. Reclamation of Areas Disturbed During Construction

In addition to reclamation of areas disturbed by mining, features such as haul roads and diversion ditches not having long-term use would be removed and their sites reclaimed. Equipment which is not reusable would be buried in the mined area. The final reclaimed state of these specific areas would blend with the surrounding areas.

Figure I-10.–Proposed postmining topography.

TABLE I-2.--Plants to be seeded or transplanted for reclamation

Note.--Reclamation work would be continuously monitored by qualified reclamation specialists employed by the company.

Grasses and forbs

Native plants:	Rate/acre[1] (pounds)	Introduced plants:	Rate/acre (pounds)
Wheatgrass	4	Nordan crested wheatgrass	1
Bluebunch wheatgrass or Whitmar wheatgrass	2	Smooth brome	1
Slender wheatgrass	2	Pubescent wheatgrass	1
Thickspike wheatgrass	2	Alfalfa	1
Green needlegrass	4	Yellow sweetclover	1
Prairie sandreed grass	2	Total pounds per acre	22
Blue grama grass	1		
Skunkbush sumac	Trace		
Nuttall saltbush	Trace		

Shrubs and trees

Caragana[2]	Old Man Wormwood	Purple willow
Russian olive[2]	Matrimony vine	Siberian elm[2]
Autumn olive[2]	Virginia creeper	American plum
Cottonwood	Crab apple	Ponderosa pine
Golden willow	Chokecherry	Black locust[2]
Buffalo berry	Honeysuckle	Scotch pine[2]
	Juniper	

[1]Based on pure live seed.
[2]Introduced species.

H. ADDITIONAL REQUIREMENTS TO MEET STATE AND FEDERAL REGULATIONS

1. Mitigating Measures (Stipulations)

a. The application for a strip mining permit must demonstrate compliance with the Federal Strip Mining Control and Reclamation Act of 1977, the Montana Strip and Underground Mine Reclamation Act of 1973, the Montana Coal Conservation Act of 1973, and regulations pursuant to these laws.

b. Federal regulations implementing the Migratory Bird Treaty Act provide that no actions can be taken that would result in the destruction of migratory birds, their eggs, or nests. Migratory birds (50 CFR 10.13) include most birds currently nesting on the Peabody area. The FWS (U.S. Fish and Wildlife

Service) has authority to permit removal of these nests subject to stipulations. Thus far, Peabody has not applied for permits under the Migratory Bird Treaty Act and no action can be taken until permits are issued or the FWS determines that permits will not be necessary. The Endangered Species and Bald Eagle Acts must also be complied with.

c. EPA regulations require a review to determine the best available control technology where potential fugitive dust emissions are equal to or greater than 250 tons per year. The mine operator, in this case Peabody Coal Co., must employ the best management practices for fugitive dust, regardless of predicted concentrations during operation. Thus the mining plan and the Agency's approval should use an appropriate combination of the following fugitive dust controls:

1. Pavement or equivalent stabilization of all haul roads used or in place for more than 1 year.

2. Treatment with semipermanent dust suppressants of all haul roads used or in place for less than 1 year or more than 2 months.

3. Watering of all other roads in advance of and during use whenever sufficient unstabilized material is present to cause excessive fugitive dust.

4. Reduction of fugitive dust at all coal dump (truck to crusher) locations through use of negative pressure bag house or equivalent methods. Inclusion of conveyor and transfer point covering and spraying and the use of coal loadout silos.

d. The Big Sky mine is in a "nonattainment area"; thus, the Montana Air Quality Bureau must write a State implementation plan which provides for attainment of the primary air quality standards and the secondary air quality standards for total suspended particulates (TSP). The state implementation plan should not allow for the construction or modification of any major stationary sources in any nonattainment area "if the emissions from such facility(ies) will cause or contribute to concentrations of any pollutant for which a national ambient air quality standard is exceeded in such area," [Sec. 110 (a) (2) (I)] unless particulate emissions are "offset" by a similar decrease in these emissions elsewhere. Major stationary sources for particulates are those which have potential particulate emissions in excess of 250 tons per year [Sec. 169.(1)]. The Big Sky mine exceeds this amount and has been categorized as a "major stationary source."

e. In compliance with Executive Order 11593 and State Policy, the company must meet the requirements of the Montana State Historic Preservation Officer for a cultural resources clearance.

2. Mitigating Measures (Construction)

a. Existing access roads and facilities must be used throughout the life of the mine expansion. The only construction to take place would be the building of haul-roads extensions.

b. Additional requirements may be imposed by the department if special drainage or steep terrain problems are likely to be encountered. Topsoil will be salvaged from all roadways.

c. All cut-and-fill slopes resulting from construction of haul roads outside the area to be mined must be stabilized and revegetated during the first seasonal opportunity.

d. Drainage ditches must be constructed on both sides of any throughcuts, and the inside shoulder of a cut-fill section, with ditchrelief cross drains being spaced according to grade. Water must be intercepted before reaching a switchback or large fill, and must be drained off or released below the fill.

e. Clinker must be placed at the discharge points of the outlet pipes of the settling ponds.

f. All water discharges must meet State and Federal standards.

g. Culverts or bridges must be used where roadways cross drainages, so as not to affect flow or sediment load.

h. Silting basins must collect sediment washed from roadway or unreclaimed areas.

3. Mitigating Measures (Mining)

a. All mining activities, including highwall reduction and related reclamation, must cease 100 feet from a property line, a permanent structure, an unminable, steep, or precipitous terrain, or from any area determined by the Montana Department of State Lands, with concurrence of the Secretary of the Interior, to be of unique, scenic, historical, cultural, or other special value pursuant to Section 522 of the Surface Mining Control and Reclamation Act and Section 9 (50-1042 RCM, 1947) of the Montana Strip and Underground Mine Reclamation Act.

b. The company must receive approval from the regulatory agencies prior to the utilization of chemical dust suppressants.

c. The company may be required to mine more of the McKay coal in two excluded areas (fig. I-6), under the Coal Conservation Act (Sec. 50-Ch. 14 RCM, 1973) by the Montana Department of State Lands, or under the Federal 30 CFR 211 regulations.

d. Haul roads through permitted areas must be allowed providing that their presence does not delay or prevent recontouring or revegetation on immediately adjacent spoils.

e. The company would be required to replace existing wells adversely affected by mining, if grievances were filed by well owners.

4. Mitigating Measures (Reclamation)

a. Materials which are not conducive to revegetation techniques, plant establishment, and growth must not be left on the top or within 8 feet of the top of regraded spoils or on the surface of any other affected areas. State and Federal agencies have the authority to require that problem materials be placed at a greater depth.

b. Boxcut spoils or portions thereof must be hauled to the final cut if:

1. Excessively large areas of the mine perimeter would be disturbed by proposed methods for highwall reduction or regrading of boxcut spoils; or

2. Material shortages in the area of the final highwall, or spoil excesses in the area of the boxcut, would likely preclude effective recontouring.

c. All backfilling and grading must be completed within 90 days after the Montana Department of State Lands has determined that the operation is completed or that a prolonged suspension of work in the area will occur.

d. In all cases, the final pit must be backfilled so as to cover all exposed coal seams with at least 4 feet of nontoxic fill material.

e. The transition from undisturbed ground must be blended with cut or fill to provide a smooth transition in topography.

f. Stockpiles of salvaged topsoil must be located in areas where they would not be disturbed by ongoing mining operations and

would not be subject to undue wind erosion or surface runoff. All unnecessary compaction and contamination of the stockpiles must be prevented. Once stockpiled, the topsoil must not be rehandled until replaced on regraded disturbed areas.

g. The mine operator must take all measures necessary to assure the stability of topsoil on graded spoil slopes. If necessary, the graded spoil surface must be ripped or disced to provide a more natural interface between the spoil and topsoil.

h. Any application for a permit or an accompanying reclamation plan, which for any reason proposes to use materials other than or along with topsoil materials for final surfacing of spoil or other disturbances, must document problems of topsoil quantity or quality. The application or plan must also show that the topsoil substitute proposed:

   1. Would not contribute to or cause pollution of surface or underground waters;

   2. Would support a diverse cover of predominantly native perennial species equivalent to that existing on the site prior to any mining-related disturbance.

i. Terracing may be required to conserve moisture and to control water erosion on all graded slopes during the grading process.

j. The cover crop to be used must be specified and seeding rates included. If millet is to be used its suitability should be referenced.

5. Mitigating Measures (Abandonment)

a. Upon abandonment of any road or railroad the area must be conditioned and seeded and adequate measures taken to prevent erosion by means of culverts, water bars, or other devices. Such devices must be abandoned in accordance with all provisions of Chapter 325, Session Laws of Montana, 1973, and MAC 26-2.10 (10)S-10330 and MAC 26.210 (10)S10340 of the Rules and Regulations adopted pursuant thereto. Upon completion of mining and reclamation activities, all roads must be closed and reclaimed unless the landowner requests in writing, and the Montana Department of State Lands concurs, that certain roads or specified portions thereof are to be left open for future use.

b. In the case of abandoned roads, the roadbeds must be ripped, disced, or otherwise conditioned before topsoil is replaced. The Montana Department of State Lands may prescribe additional alternate conditioning methods for the reclamation of abandoned roadbeds.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

THE FOLLOWING SECTION DESCRIBES THE PHYSICAL, BIOLOGICAL AND CULTURAL ENVIRONMENT IN WHICH PEABODY COAL COMPANY PROPOSES TO EXPAND ITS EXISTING BIG SKY MINE. THE DESCRIPTION FOCUSES ON ENVIRONMENTAL DETAILS MOST LIKELY AFFECTED BY PEABODY COAL COMPANY'S PROPOSAL.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

A. GEOLOGY

1. Topography and Geomorphology

The permit area topography (fig. I-6) consists of flat-topped hills, cliffs approximately 100 feet high, and valleys partially filled with colluvium (slope deposits) and alluvium (stream deposits). Most stream channels are sharply incised into otherwise gently sloping valley floors. Resistant sandstone cliffs in the Fort Union Formation are commonly capped with clinker (baked and fused rock). Elevations range from about 3,650 feet along the drainage divide between Armells and Rosebud Creeks in the eastern portion of the leasehold to about 3,070 feet at the confluence of Emile and Miller Coulees.

The landscape (both hillslopes and stream channels) is in balance with runoff and natural erosion rates. The landscape remains unchanged during long periods of time, possibly years. Baseline runoff and natural erosion data are unavailable because measurable runoff occurs so infrequently; therefore, discharge and sediment yield must be estimated by general means. (See Hydrology, Surface Water, chapter II.) Runoff occurs in response to snowmelt or intense rainstorms and is extremely unpredictable. Natural erosion rates are high because of the semiarid climate and steep headwaters. (See table II-1, Hydrology, Surface Water, chapter II.) When erosion does occur, it occurs quickly, during major storms. Erosion and sediment transport are sporadic and are usually associated with thunderstorms, where raindrop impact plays an important role. Stream channels contain flow sufficient to erode and transport sediment only for a few hours to at most a few days each year. The precipitation data presented in the climate discussion represent 24-hour amounts and do not reflect intense thunderstorms.

2. Stratigraphy, Overburden and Interburden

Several coal beds underlie the region. Some are too thin and too deeply buried to be economically mined. The Rosebud coal bed, however, is 25-30 feet thick and is separated by 6-35 feet of interburden[1] from the underlying 6- to 8-foot thick McKay coal bed (fig. II-1). These two beds are subbituminous and have low sulfur content.

The overburden[2] and interburden consist of interbedded sandstone, siltstone, and shale of the Tongue River Member of the Fort Union Forma-

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[1]Rock between coal seams.

[2]Rock overlying the Rosebud coal seam.

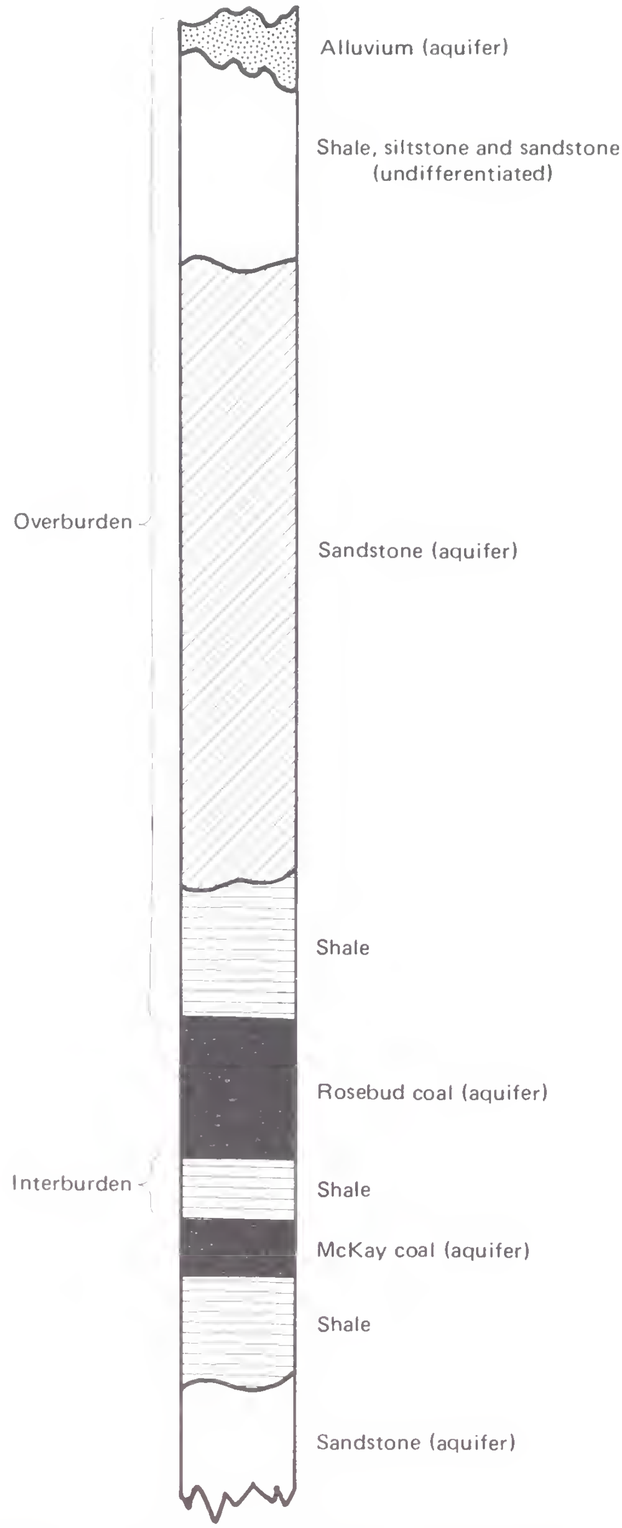

Figure II–1.—General geologic section. Vertical scale, approximately 1″= 40 feet. All rock units vary in thickness, although the two coal beds and the interburden are relatively less variable than other units.

tion. In some places burning of coal beds has produced clinker in overlying rock units. The most prominent unit in the overburden is a resistant sandstone that is as much as 100 feet thick. Locally, some units are well cemented by carbonate material. Thin carbonaceous shales and shaley coals occur at various intervals. Carbonaceous material is commonly scattered along bedding planes in the siltstones and claystones. Sedimentary beds dip less than 1 degree northwesterly toward Armells Creek in the northwest part of the permit area, and southeasterly in the southeast part.

The company has submitted data from geochemical and physical tests for 24 core holes (fig. II-2). Sample depth ranged from less than 1 foot to the gray shale underlying the McKay coal bed. Laboratory analyses representing each change of strata (not less than 2-foot nor more than 10-foot intervals) were compared to State suspect levels (defined in table II-1). Values determined for manganese, mercury, and selenium concentrations all fell below suspect levels established by the Montana Department of State Lands. Others, such as pH, SAR, boron, copper, lead, zinc, and nitrate, were found to exceed State suspect levels in some intervals. Numerous strata exceeded State suspect levels for soluble salts, texture (clays), cadmium, molybdenum, and nickel.

Overburden traits that exceed State suspect levels are discussed in detail in appendix A. In summary, excessive concentrations of cadmium, molybdenum, and nickel were found in strata throughout the lease area. The interburden and other strata adjacent to the coal beds frequently contain traits that exceed suspect levels. These strata have the highest clay content and frequently contain the highest concentrations of cadmium, molybdenum, and nickel. Interburden in the eastern portion of the lease area, sec. 13, contains excessive lead concentrations associated with strata having low pH values (4.1-4.3).

The highest concentrations of zinc, nitrate, and soluble salts usually occur in near-surface strata (70 ft in depth or less). Excessive concentrations of nitrates and soluble salts are found in secs. 13, 14, and 15 but are not found in sec. 22.

3. Minerals Other Than Coal

Clinker is the only other known commercial mineral resource in the lease area. It is an extremely small fraction of that available in the Northern Powder River Basin.

4. Petroleum and Natural Gas

Although lease M-29725 overlaps the proposed mine area, there are no petroleum or natural gas reserves beneath the lease area. Any future exploration for these mineral commodities would have to be conducted in coordination with mining activities or delayed until the wellsite was mined out.

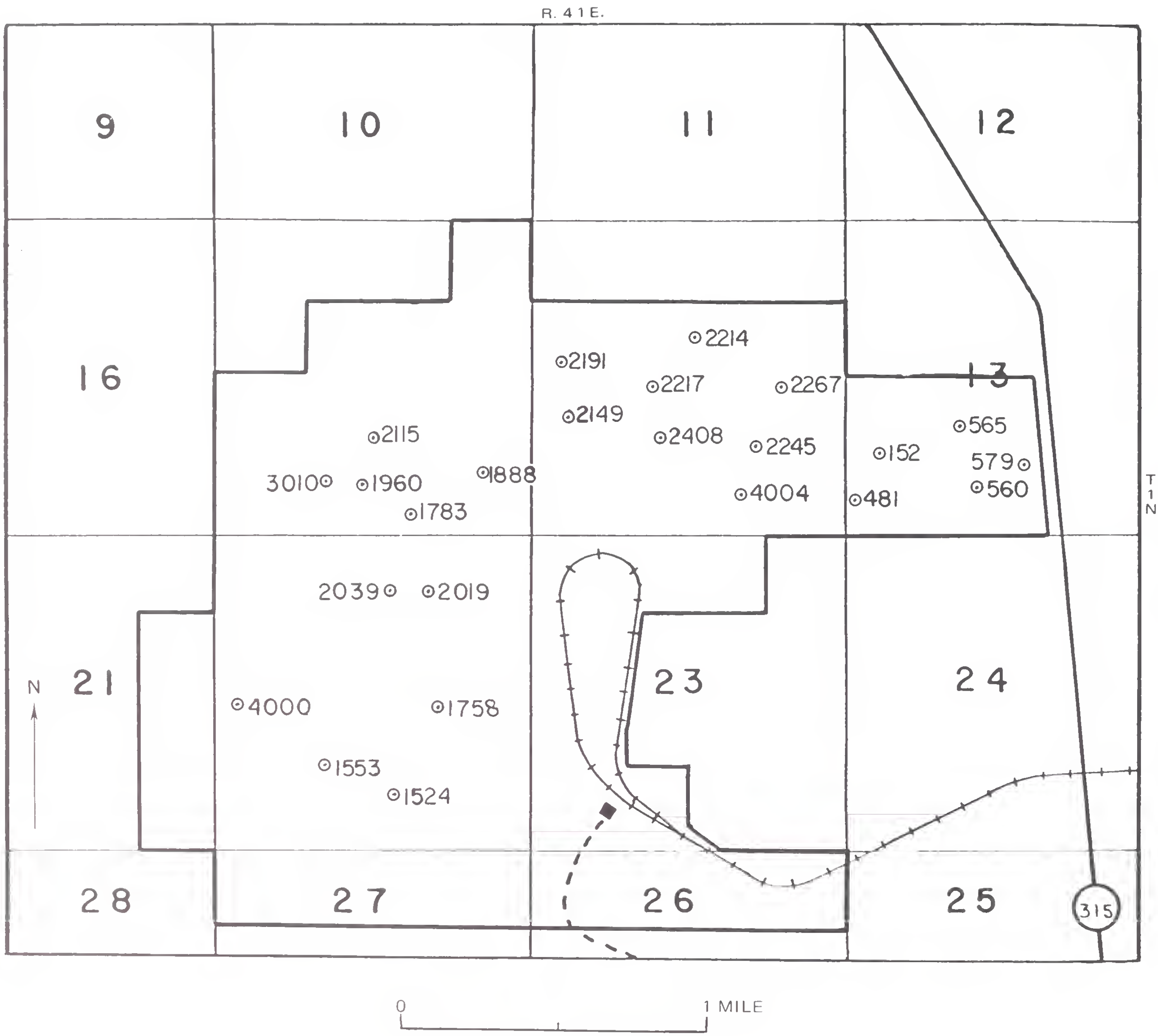

Figure II-2.—Drill hole locations.

Table II-1.--State suspect levels[1]

[Suspect levels are given in parts per million unless otherwise indicated]

Parameter	Suspect level
pH	8.8-9.0
Conductivity (soluble salts)	4-6 mmhos/cm
Sodium-adsorption-ratio	12
Texture	40-percent clay
Boron	8
Cadmium	0.1-1
Copper	40
Iron	Not defined
Lead	(pH 6 (10-15); pH 6 (15-20))
Manganese	60
Mercury	400-500 ppb
Molybdenum	0.3
Nickel	1.0
Selenium	2.0
Zinc	40
Ammonium - nitrogen	Not defined
Nitrate - nitrogen	Federal drinking water standard[2] is 10 Federal livestock standard is 45

[1]State suspect levels are intended to determine overburden suitability for revegetation and are not indicative of potential ground-water contamination; however, water quality is closely related to solubility of overburden constituents.

[2]Water standards are used because of the high solubility of nitrates.

B. HYDROLOGY

1. Surface Water

Most of the permit area is drained by two ephemeral streams (Miller Coulee and Emile Coulee) and their tributaries (fig. II-3). A small portion in the east is drained by Hay Coulee. All streams in the leasehold eventually drain eastward to Rosebud Creek.

Miller Coulee has been disrupted by existing mining operations in secs. 22 and 27. Its headwaters are dammed; excess flow is routed around mining operations through sediment settling ponds to an impoundment. Mining operations are also underway in the Emile Coulee watershed. The stream remains undisturbed except for those portions on which settling ponds and a railroad crossing have been constructed.

Peak flows from Emile and Miller Coulees generally occur in late winter or early spring when warm temperatures produce rapid snowmelt, or after intense summer thunderstorms. Flow was observed along Miller Coulee, in March, June, July, and August 1972 and in April, May, and June 1973. Table II-2 presents estimates of annual runoff and peak discharges for 10-, 25-, and 50-year recurrence intervals for the several segments of the Big Sky mine, as shown in figure II-3. Estimates of peak discharges were computed using methods described by Johnson and Omang (1976).

Annual runoff was based on 0.26 of an inch per year, which was determined for station 06296000 Rosebud Creek near Forsyth, with 6 years of record (1947-53). This value is low when considering the disparity in drainage areas--about 4 square miles for the mine area and 1,260 square miles for Rosebud Creek. (Runoff per unit area decreases substantially as the drainage area increases.)

a. Water quality

The limited surface water data available for Emile Coulee indicate total dissolved solids values of 376-381 mg/L of a calcium sulfate type water (Dollhopf and others, 1977).

Sediment yield, like precipitation and runoff, is highly variable, ranging from zero to large amounts (greater than 10,000 ppm). The amount of variation depends upon the volume of runoff and the intensity of the precipitation event.

b. Present use

Mining is being conducted in sec. 22, T. 1 N, R. 41 E. This impoundment is in a final cut of earlier operations. Surface water is also present in one pond in the northern part of sec. 24. A spring in Emile Coulee (SW1/4SW1/4 sec. 24, T. 1 N, R. 41 E.) has been used for livestock.

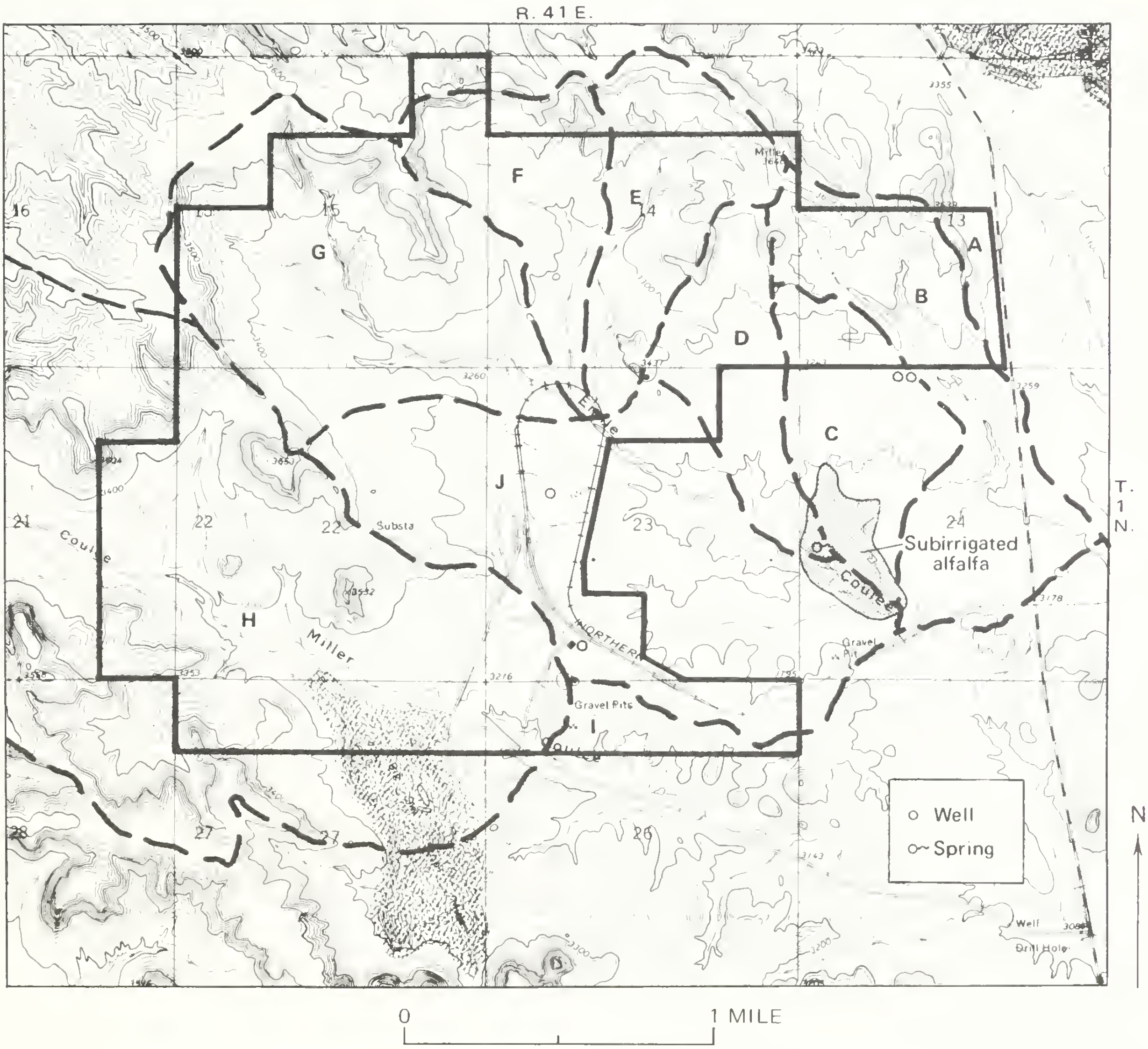

Figure II-3.—Drainage basins of the Big Sky permit area.

TABLE II-2.--Hydrologic data for watersheds in Big Sky lease

		Area (acres)	Estimated[1] annual runoff (acre-ft)	Estimated[2] annual sediment yield (tons)	Estimated peak discharge for indicated recurrence interval (ft^3/s) 10 years	25 years	50 years
	Upstr fm lease[3]	--	--	--	--	--	--
A	Within lease	32	0.7	--	--	--	--
	Combined	32	.7	--	--	--	--
	Off lease	13	.3	25	--	--	--
B	Within lease	147	3.2	280	15	27	39
	Combined	160	3.5	305	16	28	41
	Upstr fm lease	--	--	--	--	--	--
C	Within lease	51	1.1	130	--	--	--
	Combined	51	1.1	130	--	--	--
	Upstr fm lease	--	--	--	--	--	--
D	Within lease	122	2.6	270	15	28	40
	Combined	122	2.6	270	15	28	40
	Upstr fm lease	64	1.4	680	5	9	13
E	Within lease	192	4.2	2,040	25	45	65
	Combined	256	5.6	2,720	25	45	65
	Off lease	38	.8	410	3	6	9
F	Within lease	192	4.2	2,090	27	49	72
	Combined	230	5.0	2,500	30	53	78
	Upstr fm lease	--	--	--	--	--	--
F[1]	Within lease	19	.4	--	--	--	--
	Combined	19	.4	--	--	--	--
	Upstr fm/off lease	64	1.4	210	--	--	--
G	Within lease	499	10.8	1,630	33	57	82
	Combined	563	12.2	1,840	36	62	89
	Upstr fm/off lease	1,214	26.3	960	55	94	130
H	Within lease	799	17.3	630	62	110	160
	Combined	2,013	43.6	1,590	89	152	220
	Upstr fm lease	--	--	--	--	--	--
I	Within lease	77	1.7	--	--	--	--
	Combined	77	1.7	--	--	--	--
	Upstr fm lease	--	--	--	--	--	--
J	Within lease	397	8.6	590	--	--	--
	Combined	397	8.6	590	--	--	--

[1]Calculated by multiplying the estimated sediment yield for the entire watershed (see appendix B) by the proportion of the watershed within and above the lease area.

[2]Estimated peak discharges have associated standard errors of 80, 93, and 88 percent for the 10, 25 and 50 year estimates respectively (Johnson and Omang, 1976). This means, for example, that two-thirds of the time, the recorded 10-year peak discharge would be within ±80 percent of the estimated value.

[3]Upstream from lease.

2. Ground Water

a. Aquifers

The five near-surface aquifers in the vicinity of the Big Sky mine are the Emile Coulee alluvial aquifer, the Rosebud coal, the McKay coal, sandstone beds that overlie the Rosebud coal, and sandstone beds that underlie the shale beneath the McKay coal. In general, the sandstone aquifers in the Colstrip area are more permeable than the coal aquifers. As a result, most of the wells in the area draw ground water from the sandstone aquifers. Clinker zones appear in geologic cross sections but no data are available to determine their hydrologic significance.

The Emile Coulee alluvial aquifer consists of sands, silts, and clays. Alluvial ground water is recharged by infiltration of surface flow and recharge from the adjacent sub-McKay aquifer. In the eastern portion of sec. 23, Emile Coulee contains no active stream channel, suggesting that normal surface flow from the headwaters completely infiltrates before reaching this far downstream. Alluvial ground water is in part discharged by phreatophytic (water-loving) vegetation.

The ground-water source of a spring located along the south bank of Emile Coulee in the southwestern portion of sec. 24 is unknown, but it may be fed by alluvium, the sub-McKay aquifer, or both.

The Rosebud coal aquifer is widespread, but, as indicated by aquifer tests in many places, it is not sufficiently permeable to provide water for stockwells (Van Voast, 1977, p. 24). However, two wells obtain water from this aquifer in the western part of T. 1 N., R. 41 E. The aquifer is recharged from the overlying sandstones, and is discharged to phreatophytic vegetation along the outcrop and to the underlying McKay coal aquifer.

The McKay coal aquifer is also widespread and has permeability characteristics similar to the Rosebud coal aquifer. One well in the northern part of T. 1 N., R. 41 E., obtains water from the McKay. This aquifer is recharged from the overlying rocks and discharged to vegetation along the outcrop and to underlying aquifers.

The overburden aquifer consists of a massive sandstone which makes up almost the entire thickness of the overburden in the vicinity of Miller Coulee. When mining was taking place in Miller Coulee, water entered the mine from this aquifer at a maximum rate of about 200 gallons per minute. In the vicinity of Emile Coulee, this aquifer is separated from the Rosebud coal by shale and siltstone beds. The sandstone bed is likely to contain water only in the upper reaches of Emile Coulee.

The recharge of the overburden aquifer is largely from infiltration of rainfall and snowmelt west of the minesite. Discharge is probably largely through phreatophytic vegetation and through downward leakage to

the underlying Rosebud coal. Stock wells in the northern part of T. 1 N., R. 41 E., probably obtain water from this aquifer.

The sandstone that underlies the McKay coal is the most important aquifer in the immediate vicinity of the Big Sky mine, because the other aquifers have been removed by erosion east and south of the mine. No test data are available for the sub-McKay aquifer; however, wells in the area that yield several tens of gallons per minute from these rocks indicate a relatively high permeability compared to the coal aquifers. This aquifer is recharged by percolation from overlying aquifers and by direct infiltration from rainfall and snowmelt where the overlying aquifers are absent. Discharge is by downward percolation and through phreatophytic vegetation. Existing wells in the sub-McKay aquifer include supply wells for the office and tipple at the mine (sec. 23) and two wells in the northern part of sec. 24. The spring in Emile Coulee (sec. 24) may be fed by a near-surface sandstone below the McKay aquifer. The subirrigated part of the alfalfa field in sec. 24 is probably fed from this sandstone aquifer.

b. Movement

Ground water movement in the alluvial aquifer is in a downstream direction.

Piezometric surface maps of the Rosebud and McKay aquifers indicate that the general direction of ground-water movement is to the southeast. Some water moves vertically downward by percolation. A loss in head with depth between the coal beds and the general loss in head with depth in the area provide the necessary gradient for such downward movement.

A northeast-trending anticline (a convex upward fold), which crosses sec. 14, may affect ground water movement. The beds in secs. 15, 22, 27, and the western half of sec. 14 dip to the northwest. The beds in secs. 13, 23, 24, and the southeast part of sec. 14 dip to the southeast. This anticline probably impedes lateral ground-water movement and increases the downward percolation of ground water on the northwest side of the anticline.

c. Water quality

Lead is the only trace element in the ground water of this area found to exceed Federal standards for human consumption (0.05 mg/L) under 40 CFR 141.11 (Van Voast and others, 1977).

Waters from springs and wells in T. 1 N., R. 41 E., vary greatly in amount and in type of mineralization. No specific cation (positive ion) is predominant in ground water from any particular aquifer. However, magnesium tends to be higher in concentration than calcium or sodium in most of the samples. With only one exception the predominant anion (negative ion) is sulfate. The total dissolved solids (TDS) in water from

wells in T. 1 N., R. 41 E., ranges from 440 to 2,140 mg/L and averages 1,273 mg/L. Water from these wells is used for both domestic and livestock purposes.

The present mine encountered a considerable amount of water in a box cut in Miller Coulee in sec. 22, which came from a thick sandstone bed. This bed constitutes almost all the overburden in this part of the mine. Pumpage from the mine at this time was as much as 1 million gallons per day. Most of this water was discharged into an old mine pit to the south in SE1/4 sec. 27 where it was lost by evaporation and downward seepage. Water levels in monitor wells in the sub-McKay aquifer rose by nearly 5 feet in response to the pumping into the old pit, whereas water levels in monitor wells in the coal aquifers declined as much as 6 feet due to this pumping. Production wells were not effected by this decline.

Mining has been completed in the area where the large amounts of water were encountered. Currently (October 1978), the mine produces barely enough water to supply the water truck used for dust suppression on haul roads. Test-hole information shows that the coal is overlain by a poorly permeable shale bed that thickens to the north. It is unlikely, therefore, that large inflows would be encountered as mining proceeds in the north to Emile Coulee.

The inflow of water to the mine pits from the coal aquifers are an order of magnitude or so less that would be predicted from aquifer test data. The small amount of inflow to a mine pit (from a coal bed) is demonstrated at the Decker mine. Only 25 gpm are produced from an open face of coal that produces as much as 40 feet of drawdown adjacent to the pit.

The present water supply at the Big Sky mine consists of a well at the office and shop building that produces 25 gpm and a well at the tipple that produces 45 gpm for dust suppression, at the tipple. Both wells are in the sub-McKay aquifer. Water for dust suppression on the haul roads is obtained from the pit at the present time (October 1978). Storage at the mine is confined to a 5,000 gallon tank at the shop.

No records have been kept on water use at the present mine. Based on data from the Decker mine, where the use is about 10 acre-feet of water per million tons of coal production, the present water use at the Big Sky mine would be 23 acre-feet per year.

Water sources of importance that lie outside the permit area include two wells in the sub-McKay aquifer near the north boundary of sec. 24 that supply water to a small trailer park, and a spring in Emile Coulee (SE1/4SW1/4SW1/2 sec. 24) which is used for livestock water. (See fig. II-4.)

Ground water is also used by James Snider's subirrigated alfalfa field in the west-central part of sec. 24.

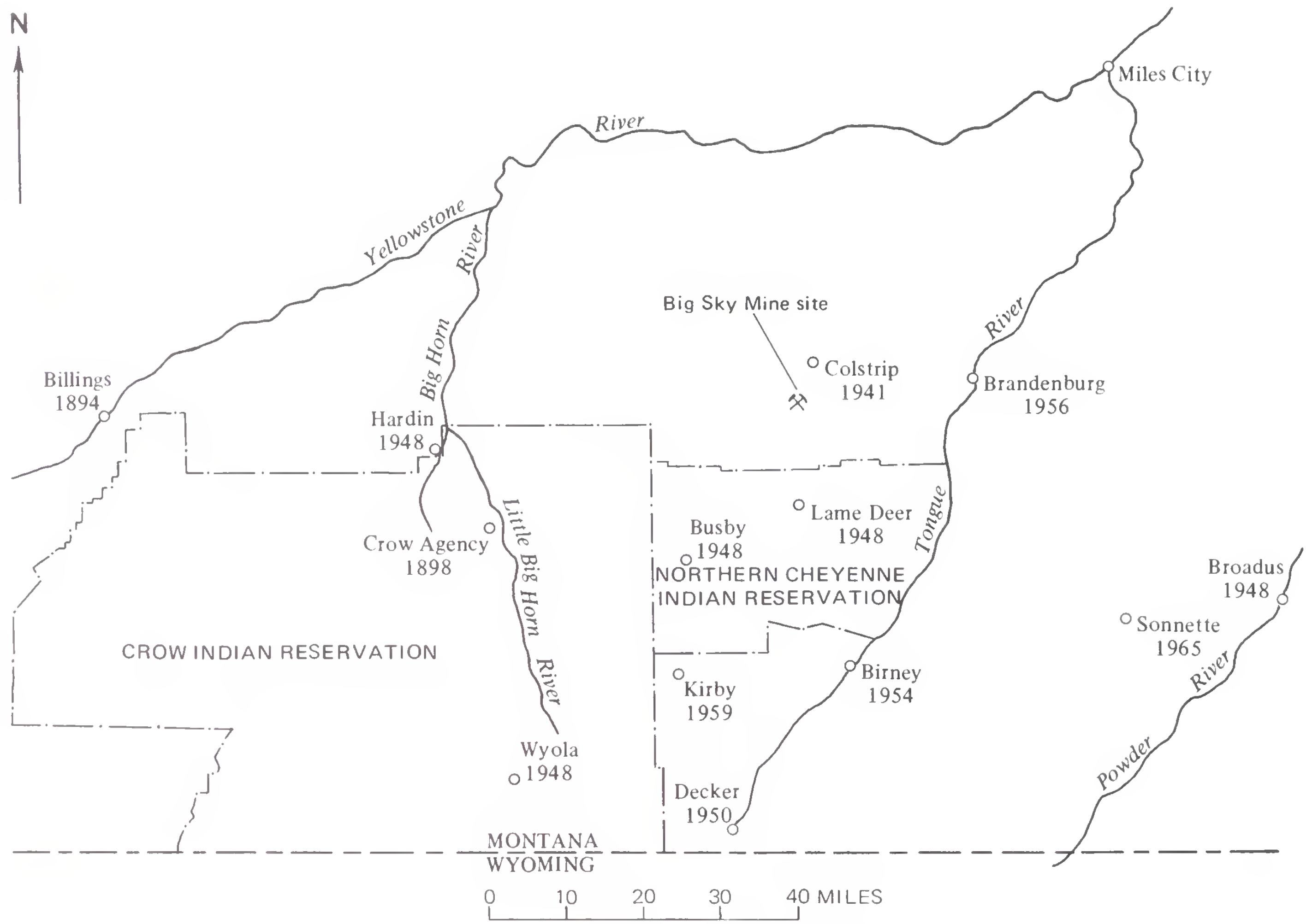

Figure II-4.—Weather station and first year of record.

C. CLIMATE

1. Introduction

The climate of the Big Sky mine and vicinity is continental steppe, typical of the Northern Great Plains. The area is semiarid, characterized by cold winters, hot summer days, cool summer nights, abundant sunshine, moderate relative humidity, and low but highly variable and intense precipitation. Most precipitation falls during late spring and early summer as thunderstorms, but periodically spring rains fail, resulting in droughts. Chinooks are common to the region, characterized in summer by hot parching winds and in winter by abrupt temperature increases often accompanied by rapidly melting snow.

2. Subregional Climate Factors

a. Precipitation

Precipitation data most characteristic of the Big Sky mine area are from Colstrip (fig. II-4), where the mean annual precipitation is 15.79 inches. Three years of precipitation data from the permit area show that precipitation is about 10 percent lower than at Colstrip (ECON, Inc., 1977). Long-term precipitation records from the Billings weather station (fig. II-4) indicate that the last 10-15 years have had above average rainfall (fig. II-5). Colstrip shows the same pattern, with mean annual precipitation increasing about an inch each decade (fig. II-6 and appendix C-1). Increased fall and winter precipitation contributed to the above-average annual precipitation.

Data from all regional stations illustrate that spring thunderstorms account for a disproportionate amount of the total annual precipitation[3] (fig. II-6). Recurrence intervals for Colstrip indicate that a 24-hour storm of at least 2 inches can be expected about every 10 years and a 3-inch storm every 200 years (table II-3; State task force, open-file report, 1978). Analysis of only the spring months shows that 1 day in every 12 years has a storm delivering more than 2 inches of rain. The largest 24-hour storm recorded at Colstrip was 3.77 inches (June, 1944). Such large precipitation events seem to occur after extended periods of dryness (fig. II-6). The variability and intensity of the rainfall patterns of the area can have a significant influence upon erosion rates and reclamation. (See Soils, Geomorphology, Vegetation, chapter II.

Periods of severe drought associated with biological and economic hardship have occurred at least 4 times in the last 100 years (Lomasson,

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[3]Data analysis and listings on file at the State task force office.

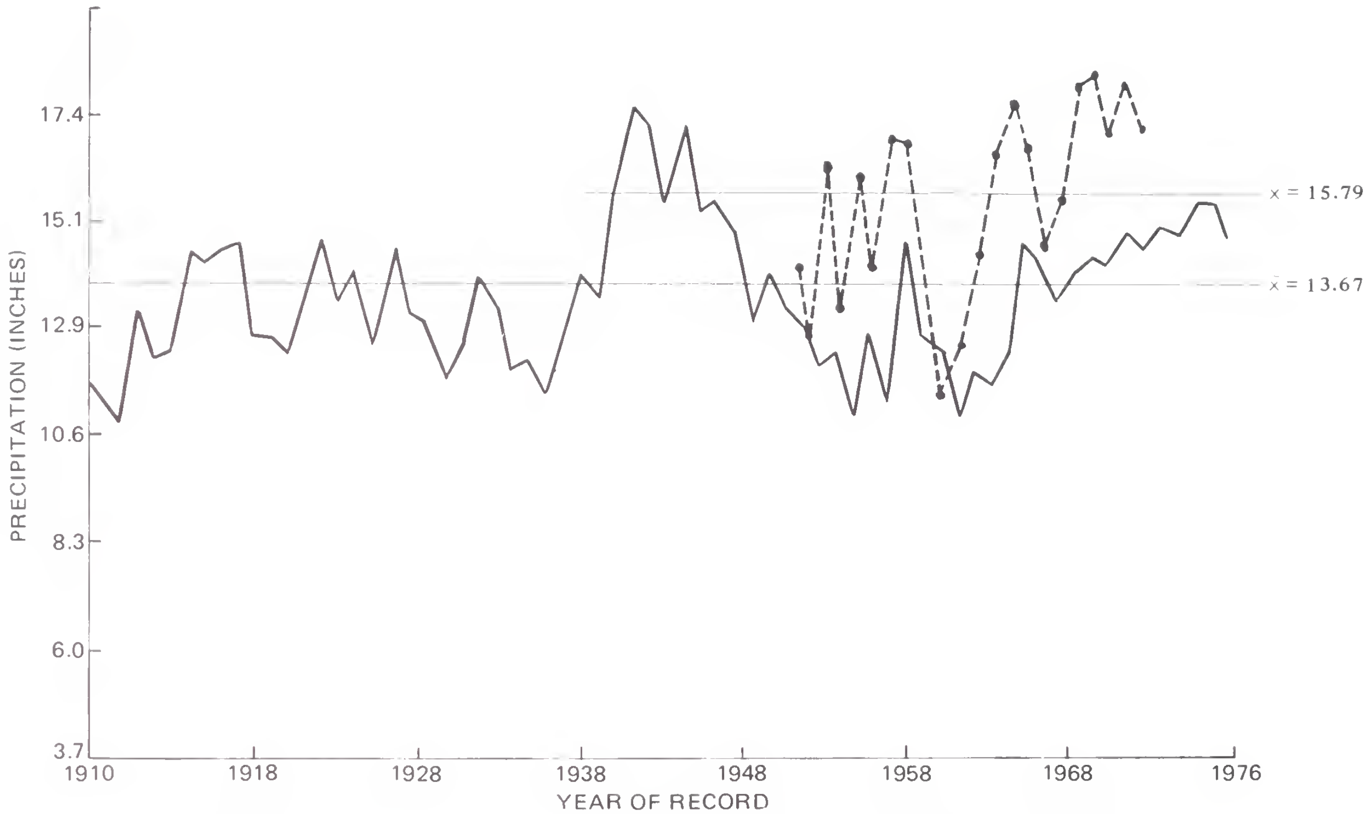

Figure II-5.–Three year running averages of precipitation at Billings (solid line) and at Colstrip (broken line).

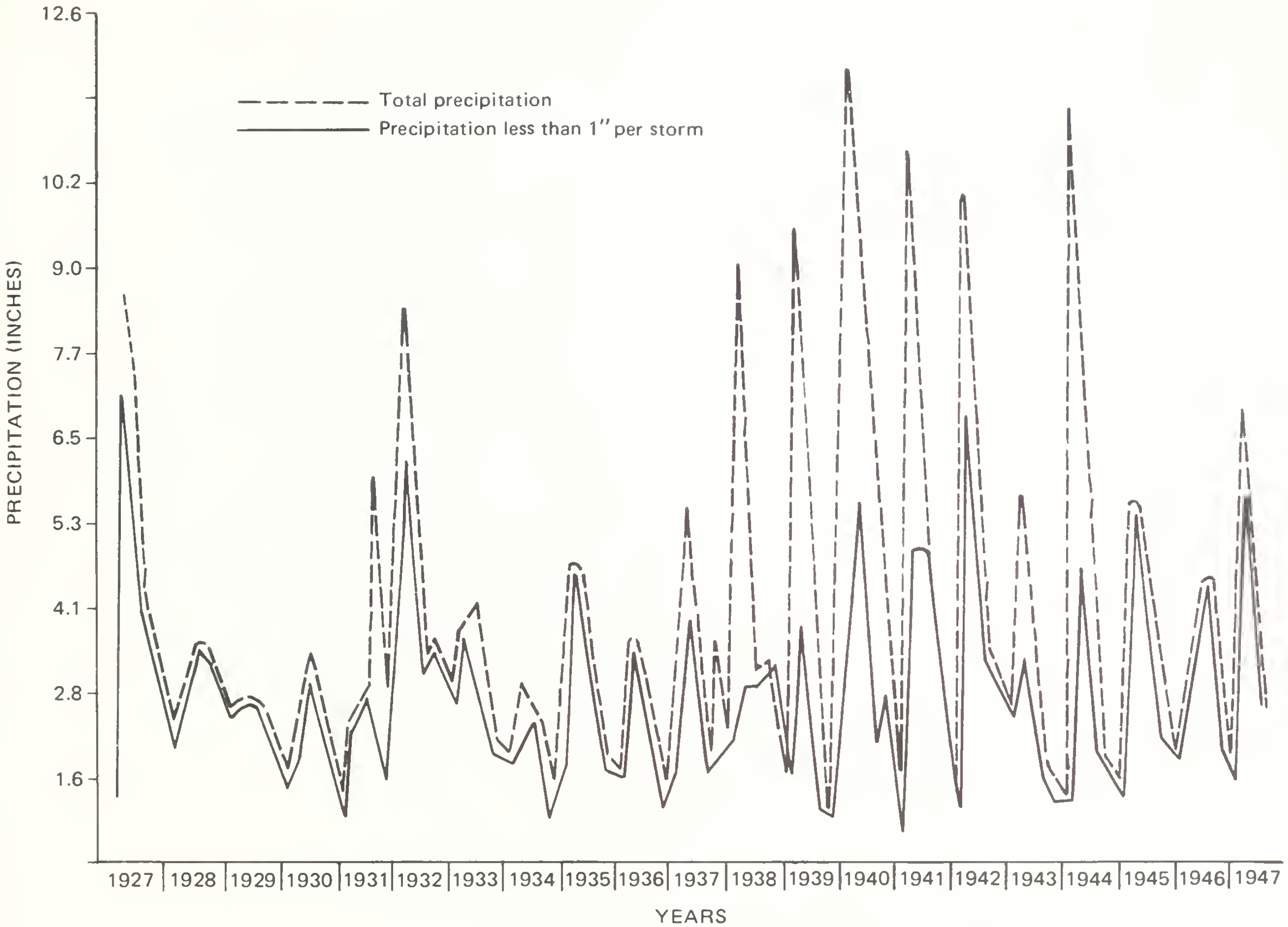

Figure II-6.—Seasonal precipitation at Billings. Period of record: 1927–1947.

1947). Drought periods may last one, two or three growing seasons without relief. Precipitation of the region has followed a 21-year cycle of wet and dry years (State task force, open-file report) which may induce environmental and economic damage to the area.

TABLE II-3.--Largest rainstorm expected during various lengths of time in the vicinity of the Big Sky mine

Weather station---	Colstrip	Brandenburg	Lame Deer	Crow Agency	Billings
Years of record---	28	21	29	77	79
Recurrence interval (yrs)	Size of largest 24-hour storm (inches)				
2--------------	1.25	1.25	1.03	1.25	1.34
5--------------	1.74	1.75	1.46	1.78	1.91
10--------------	2.04	2.11	1.74	2.15	2.27
25--------------	2.38	2.61	2.09	2.66	2.71
50--------------	2.62	3.00	2.34	3.06	3.03
100--------------	2.83	3.43	2.58	3.48	3.33
200--------------	3.03	3.88	2.83	3.93	3.62

Mean annual snowfall at Colstrip is 34.6 inches. This represents 20 percent of the total annual precipitation. Snow cover is greatest in January; the mean is about 3 inches, and usually stays at least 11 consecutive days (State task force, open-file report, 1978). Snow has been reported to fall as late as June 8 (2 inches) and as early as September 8 (6 inches).

b. Temperature, evaporation and humidity

Mean annual temperature at Colstrip is 45.9^{o}F. Forty days per year reach 90^{o}F or above, and 184 days per year have freezing temperatures (NOAA, 1971). The monthly variation in temperature for Colstrip and the Big Sky mine is shown in table II-4.

There is considerable variation in the length of the growing season (frost-free period); the mean is 117 days, and extends from May 24 to September 18. Appendix C-2 gives the probability of occurrence of the last frost of spring and the first frost of fall (as well as other temperatures).

The Colstrip area is semiarid. Mean pan evaporation is 43 inches for the period May through September at the Big Sky mine (ECON Incv., 1977). Relative humdity averages 57 percent at Colstrip (Heimbach and Super, 1974). Maximum relative humidity during the winter months is 79 percent, while the minimums are about 30 percent during the summer.

Table II-4.--Mean monthly and yearly temperature at Colstrip[1]

	Jan.	Feb.	Mar.	Apr.	May	June
Colstrip weather station------	21.0	26.6	32.2	44.8	54.4	62.7

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Colstrip weather station------	61.5	70.1	59.0	48.6	34.4	25.7	45.9

[1]U.S. Department of Commerce, NOAA, 1973, Atlas 2, Monthly normals of temperature, precipitation, and heating and cooling degree days, 1941-70; Montana, August 1973.

c. Wind

Wind data from the Big Sky mine (ECON, Inc., 1975-77) show that the dominant surface air flow is from the southwest, west, and northwest (fig. II-7). Downvalley flow is predominant; however, some upvalley flow occurs during the day, especially during the spring, summer, and fall. During the winter there is no diurnal fluctuation in wind direction; winds are from the west through the southwest. Mean annual wind speed is about 7 miles per hour, with a range of up to 50 miles per hour during the spring and fall months (ECON, Inc., 1976, 1977).

Low relative humidity, low precipitation, and above average wind speeds make September the driest, dustiest month of the year. (See Air Quality, chapter II.)

D. AIR QUALITY

1. Introduction

The Big Sky mine is located in a semiarid climate where fugitive dust[4] emissions from mining are a significant and, perhaps, long-term problem. A comparison of air monitoring data for total suspended particulate(s) (TSP)[5] from the Big Sky mine and data from relatively undisturbed areas shows that the air quality at the minesite has not only undergone considerable deterioration but has also exceeded ambient air quality standards for TSP (figs. II-9 and II-10). For these reasons, both the Big Sky mine and the Western Energy Co. (WECO). Rosebud

[4]Dust particles entrained in air currents and moved uncontrolled from a nonpoint source.

[5]Those particles which remain airborne for a period of time sufficient to be collected in a high-volume air sampler, regardless of distance traveled from the source.

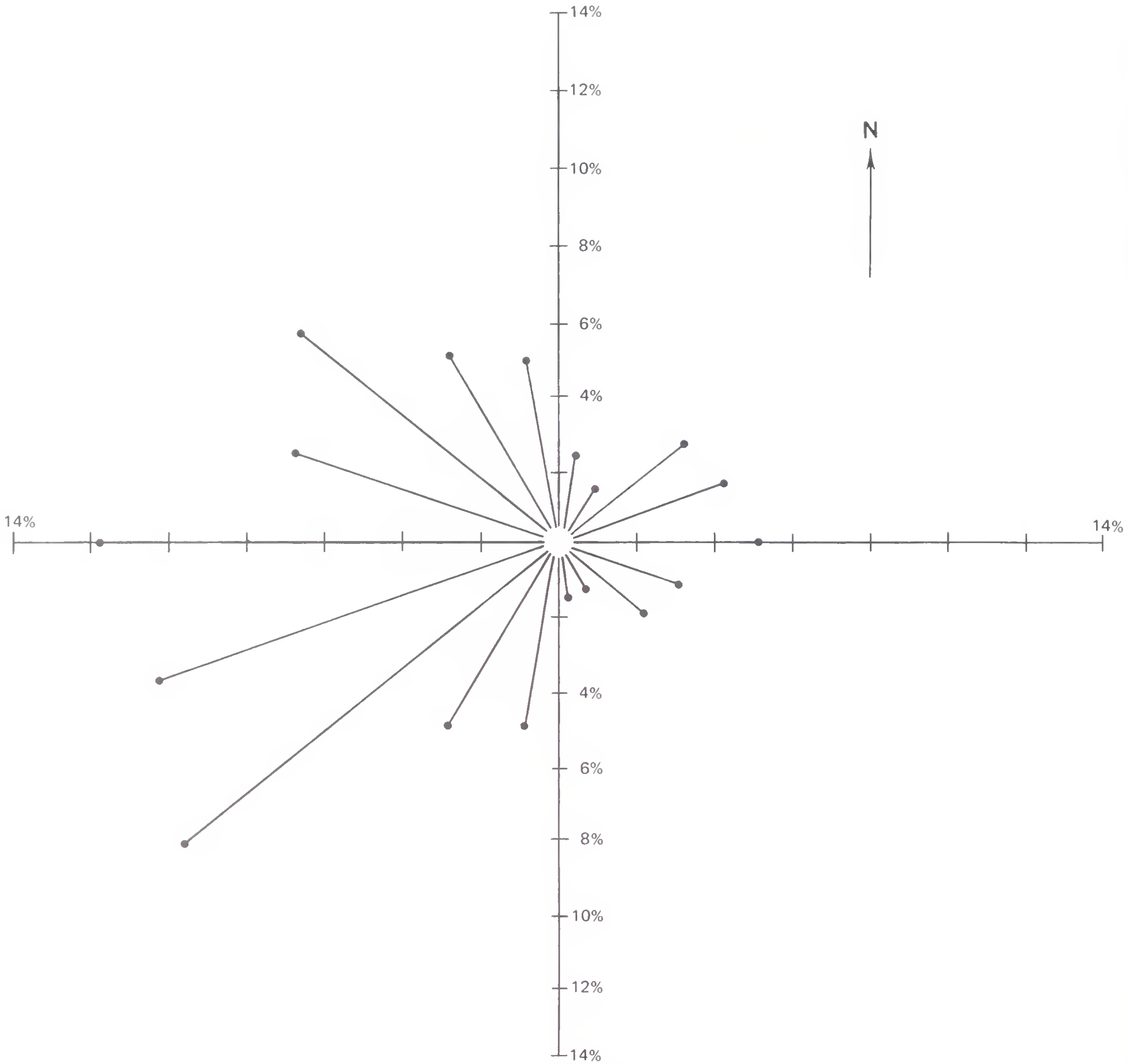

Figure II-7.—Wind direction frequency distribution at the Big Sky mine, 1975–77.

mine are included within the Colstrip Nonattainment Area[6] for TSP. A fraction of the particulate emissions associated with coal mining in the permit area may include small particles which travel great distances for extended periods of time and those in the respirable range. Trace elements found in overburden and coal dust are among those which at low concentrations are toxic to living organisms.

2. Identification of the Major Air Pollutants at the Big Sky Mine

a. Particulates

The most significant existing air quality problem associated with the Big Sky mine is fugitive dust. Fugitive dist is inadequately monitored and poorly understood. Particle-size distribution, chemical composition, and the concentration and dispersion potential of airborne particulates are characteristics necessary for evaluating the impact of fugitive dust on human health, public welfare, and the ecosystem. These data are not available for the Big Sky mine; hence, regional characteristics have been used.

1) Particle size

Particle size distribution for the region is shown in table II-5. The Colstrip site[7] has the highest recorded percentage of large particles and a greater percentage of respirable particulates than at the remote and undisturbed Youngs Creek site (about 60 miles south) on the Crow Indian Reservation. The Big Sky mine may suspend greater quantities of both large and respirable sized particulates than the relatively remote, undisturbed areas do on their own. A significant portion of the suspended particles at all sites is also in the submicrometer range.

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[6]Areas exceeding national ambient air quality standards, as defined by the Environmental Protection Agency (EPA).

[7]Particle size data were collected at Colstrip in 1974 and 1975. During this time period, strip mining was occurring in the WECO areas A and E. The Colstrip monitoring site is 275 feet above ground level and may not completely reflect surface mining impacts on particle-size distribution. The McRae Ranch site is 10 miles east-southeast and frequently downwind (fig. II-8) of Colstrip. A dirt road adjacent to the McRae Ranch site may have contributed to the large percentage of particles above 7 micrometers.

TABLE II-5.--Background particle size distribution collected from selected sites in the Northern Powder River Basin

[Sources: Youngs Creek, Northern Testing Laboratories, 1978; Rosebud County, Gelhaus, J. W., 1976. Figures shown here expressed as a percent of the total particulate weight in a cascade impactor]

Particle size[a] Class	Big Horn County Youngs Creek	Rosebud County[b] Colstrip	Rosebud County[b] McRae's Ranch
1----------	9.2	23.36	20.6
2----------	11.3	16.9	15.5
3----------	6.9	11.8	11.2
4----------	6.7	8.7	9.1
5----------	7.7	39.1	43.3
6----------	58.2	----	----

[a]Description of particle size classes:

Class 1 - 7.2 micrometers and greater. Large particles which are not likely to travel great distances and are not within the respirable fraction for humans (about 0.5 to 5.0 micrometers).

Class 2 - 3.0 to 7.0 micrometers. Intermediate sized particles, some of which may travel significant distances from the source and which are within the respirable fraction for humans.

Class 3 - 1.5 to 3.0 micrometers. Description similar to Class 2. Class 4 - 0.95 to 1.5 micrometers. Description similar to Class 2 except that particles in this size range may form what is known as aerosols (0.2 to 2.0 micrometers). Aerosols may decrease solar radiation to the ground (McCormick and Ludwig, 1967).

Class 5 - 0.49 to 0.95 micrometers. Bottom of the respirable fraction for humans.

Class 6 - Less than 0.45 micrometers. Likely to travel up to 100-1,000 kilometers from the source, suspended for indefinite periods of time (Ames Laboratory, 1977).

[b]Particle size classes for these sites are not exactly equivalent to those from Big Horn County.

2) Chemical composition

In general, the silica (as SiO_2,a respiratory irritant) content of coal in the Big Sky mine is 10 percent higher than samples from some other mines of the Powder River Basin (Northern Great Plains Resources Program, 1974). Table II-6 lists trace elements which occur in relatively high concentrations in the coal and overburden of the Big Sky mine as compared to topsoil (Conner and others, 1976; Munshower and Dupuit, 1978). Most of these elements, released to the atmosphere during blasting and handling of coal and overburden, may, at low concentrations, be toxic to biological accumulators.

TABLE II-6.--Trace elements in the overburden and coal at the Peabody Big Sky mine which occur in higher relative concentrations than in topsoil

	Very high concentrations	Moderately high concentrations
Overburden---------	Arsenic (As)	Cobalt (Co)
	Beryllium (Be)	Gallium (Ga)
	Copper (Cu)	Molybdenum (Mo)
	Lanthanum (La)	Nickel (Ni)
	Lithium (Li)	Scandium (Sc)
	Niobium (Nb)	Vanadium (V)
	Fluorine (F)	
	Zinc (Zn)	
	Lead (Pb)	
	Magnesium (Mn)	
Coal--		Copper (Cu)
		Magnesium (Mn)
		Lead (Pb)
		Nickel (Ni)
		Mercury (Hg)

Ambient trace-element concentrations in the region are very low (U.S. EPA, 1976; Gelhaus, 1976; EG & G, Environmental Consultants, 1976). The State standard for beryllium (0.01 $\mu g/m^3$/month)[8] and the proposed Federal standard for lead (1.5 $\mu g/m^3$/month) are many times higher than the baseline concentrations measured in these studies. For the remaining trace elements of concern there are no applicable air quality standards.

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[8] $\mu g/m^3$ is defined as micrograms per cubic meter of air.

3) Estimated particulate emissions

Potential particulate emissions[9] from the Big Sky mine were 5,984 tons in 1977 (table II-7). Actual particulate emissions in 1977 were probably 2,796 tons, assuming a total dust mitigation efficiency of 53 percent (table II-7). The greatest quantities of potential emissions originate from coal handling facilities, wind erosion, and overburden excavation. Current dust mitigation techniques do not use best available control technology.

A minimum of 2,300 tons of coal dust is lost from coal trains each year along the railway corridor between Big Sky and Cohasset, Minnesota (assuming a 0.1 percent loss) (Paulson and others, 1976). This loss has been documented to range from 0.1 percent (Paulson and others, 1976) to 0.42 percent (Nimerick and Laflin, 1977) with most of the loss occuring within the first 50 miles of coal transport. The loss varies with train speed, coal size, coal moisture content, and climate. The particle size distribution of the subsieve fraction of eastern Montana coal suggests that 50 percent of coal dust loss could be dispersed for many miles (Boscak and Tandon, 1974).

Fugitive dust problems from blasting occur rarely and can be regarded as a temporary nuisance. However, in high use areas (near towns or highways) the possibility of massive dust clouds being carried for many miles, causing public hazard and discomfort, does exist (Grim, 1974). Weather conditions can cause an increase in airborne noise from blasting. During inversion conditions not uncommon to the area, blasting may create a nuisance to nearby inhabitants (Grim, 1974).

4) Analysis of TSP monitoring at the Big Sky mine

The air quality monitoring network at the mine (fig. II-8) consists of four sites, each of which has a high-volume air sampler recording TSP in micrograms per cubic meter ($\mu g/m^3$) for 24 hours every sixth day. Sites 2, 3, and 4 are within the prevailing wind patterns, which carry most of the fugitive dust from current mining (Climate, chapter II). Data from site 2 are most indicative of minesite air quality problems, while sites 3 and 4 approximate offsite air quality.

Figures II-9 and II-10 illustrate the magnitude of the air quality problem at the Big Sky mine. Measurements at site 2 in 1976 exceeded the State and Federal standard for annual geometric mean for TSP (75 $\mu g/m^3$), indicating potential health hazards for mine employees. 1977 data show approximately half the 1976 value. Incomplete data for 1977 from site 4, east of the mine, suggest that the heaviest dust concentrations remain near the mine. Respirable particulates, being light, do travel away from the minesite and in some years may exceed the standards.

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[9] Potential particulate emissions are defined by the EPA as the total uncontrolled emissions from the source.

TABLE II-7.--Theoretical maximum (potential) particulate emissions and controlled (actual) particulate emissions from the Big Sky mine for 1977

[Assume production rate of 2.3×10^6 tons per year[1]]

Emission source	Potential emissions (tons/yr)	Present dust control techniques	Dust control efficiency (tons/yr)	Actual emissions (tons/yr)
Permit area				
Overburden excavation---	557.1	None	---	557.1
Coal extraction---	105.4	None	---	105.4
Coal hauling------	196.8	Watering haul roads	42.7	112.7
Coal handling-----	3,130.5	Watering transfer points hooded conveyors	53.3	1,471.3
Wind erosion---	1,968.4	Coal storage barn	72.1	549.9
Fuel combustion---	3.2	None	---	3.2
Employee transport----	23.4	Chemical and water suppression	94	1.4
Permit area totals--	5,984.8	Approximately	53	2,801.0
Regional sources				
Employee transport----	3.2	---	---	3.2
Locomotive fuel combustion----	10.1	---	---	10.1
Coal dust loss, unit-trains---	[2]2,300.0	---	---	2,300.0
Population effect, Forsyth-------	6.5	---	---	6.5
Total regional sources--	2,319.8	---	---	2,319.8

[1]See appendix D for emission factors and calculated dust control efficiency.

[2]Minimum.

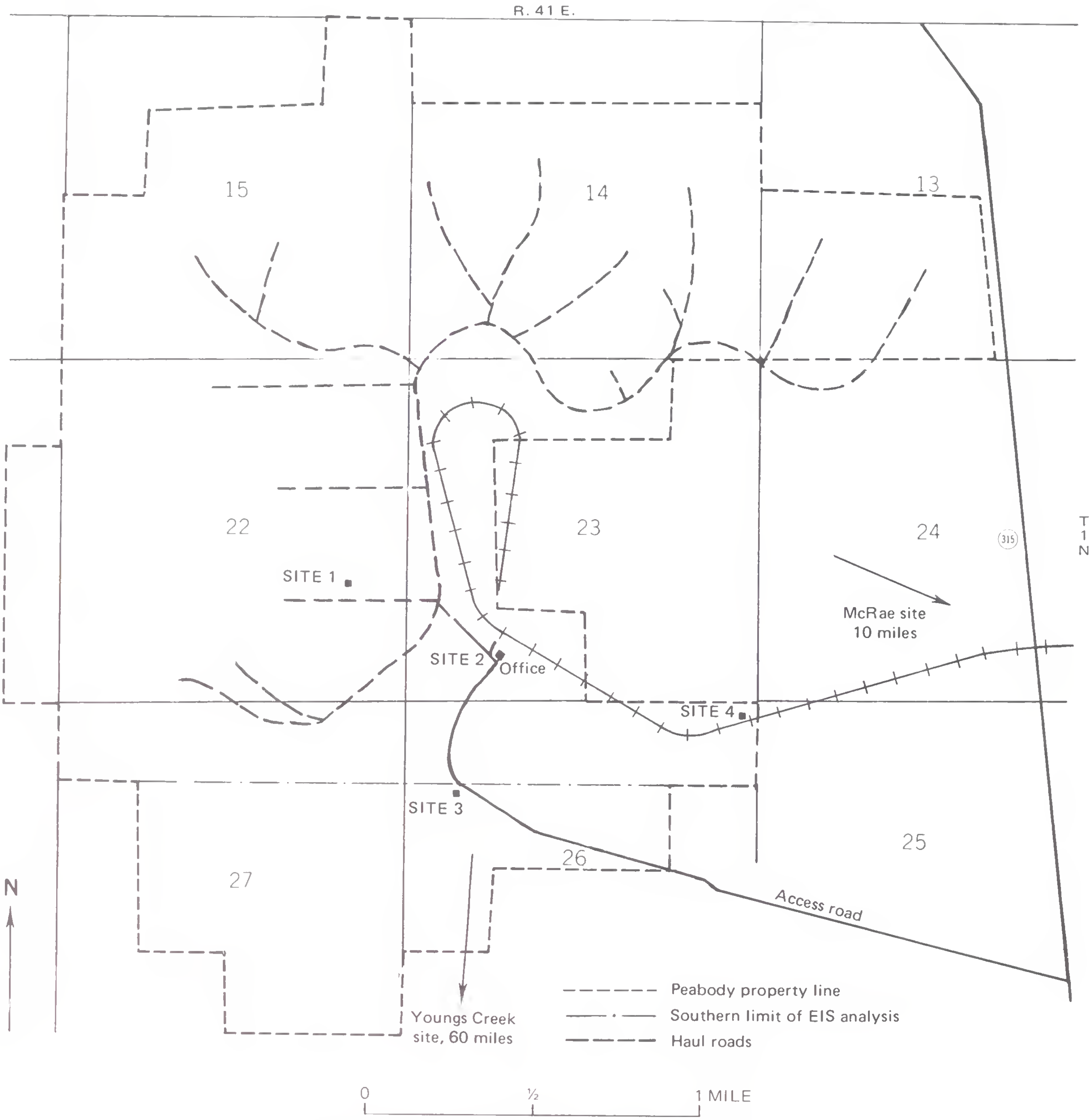

Figure II-8.–Air sampler sites at the Big Sky mine.

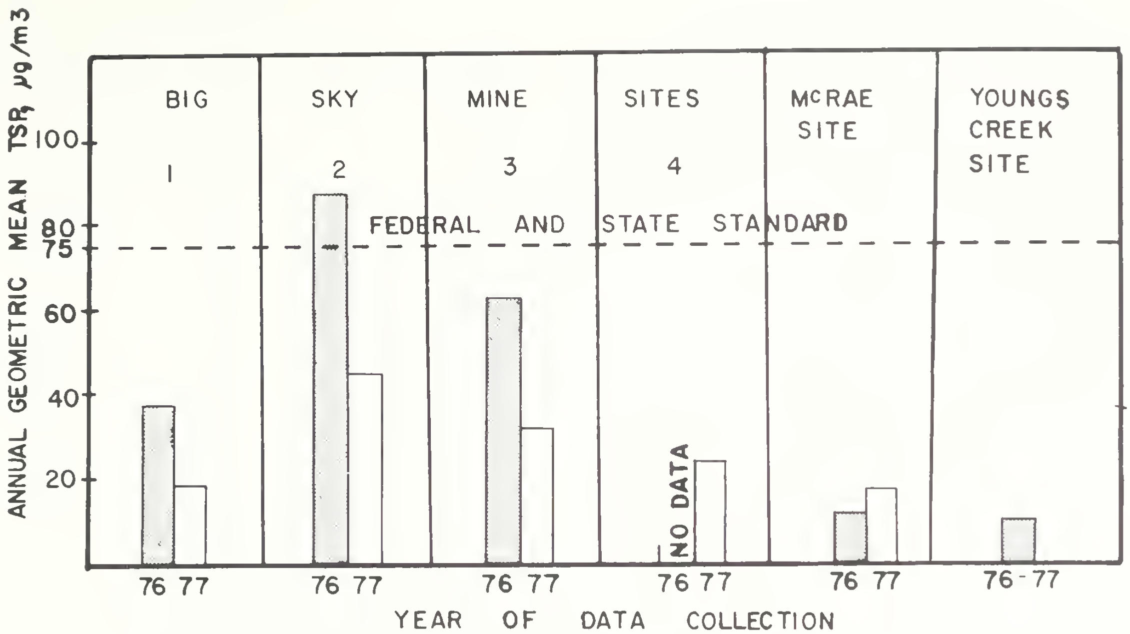

Figure II-9. –Annual geometric mean of total suspended particulate (TSP), as micrograms of dust per cubic meter of air (µg/m³).

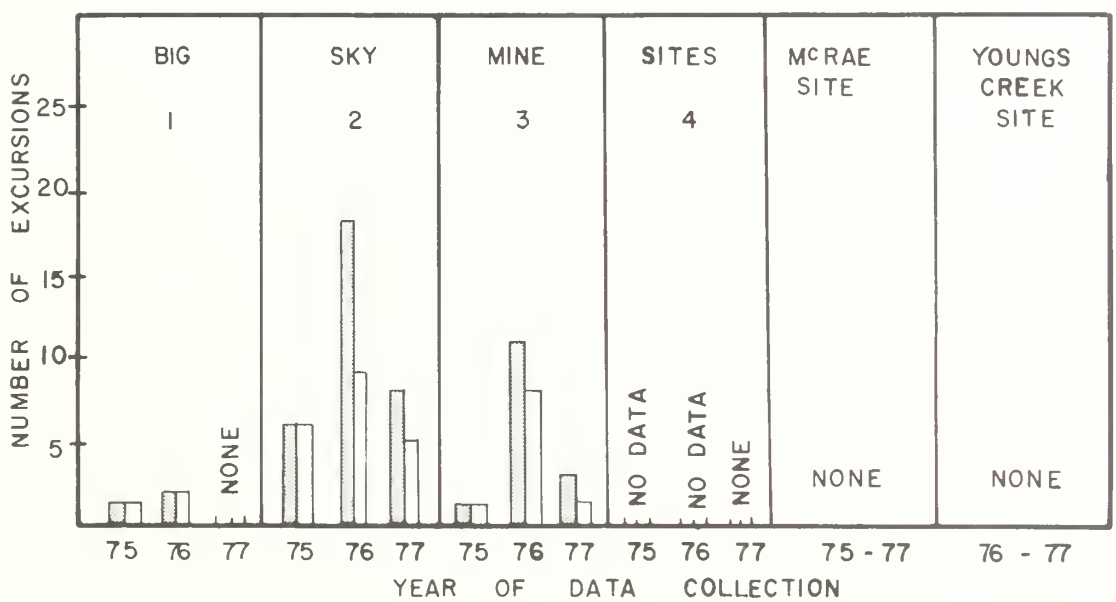

Figure II-10.–Number of times 24-hour averages were above levels considered injurous to human health and welfare. Excursions above National (150 µg/m³) and Montana (200 µg/m³) TSP 24-hour standards are shown as dark and clear bars respectively.

Figure II-10 shows the frequency with which air monitors in the permit area recorded 24-hour TSP averages which may pose human health problems. Forty-seven readings in a 3-year period could have been recorded as violations of the National Ambient Air Quality Standards (secondary, 150 $\mu g/m^3$). Some of the 24-hour readings have been 2 or 3 times the standards. The monitors in the permit area do not measure the ambient air to which the general public is exposed. Accordingly, the high readings have not been cited as violations of the National Ambient Air Quality Standards. They do indicate, as do the annual geometric means, that workers at the mine could develop health problems. Some of the levels of suspended particulate at the minesite are classified as "very unhealthful" by the EPA and warrant "warning" that premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons" may occur (U.S. EPA, 1976).

Concentrations of airborne dust at the minesite peak in July, August, and September. Peaks in July also occur at the McRae Ranch site and the Youngs Creek site, suggesting that late summer peaks are caused by seasonal changes in climate instead of by mining activities.

b. Nonattainment area designation

The AQB (Air Quality Bureau) of the Montana DHES (Department of Health and Environmental Sciences) has designated an area which encompasses Colstrip and the Peabody Big Sky mine as a "nonattainment area"[10] for TSP (fig. 11). (See Mitigating Measures (Stipulations), chapter I).

c. Gaseous pollutants

The most important gaseous pollutants associated with this strip mine are carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and hydrocarbons (table II-8). Note that most of the gaseous emissions are secondary to the mine operations, produced largely by locomotive fuel combustion and employee transportation. The total gaseous emissions from the existing mine are generally not cause for concern, although they could cause health problems for local inhabitants during atmospheric inversions. Inversions are relatively frequent during the winter in the Colstrip area (State task force, 1978).

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[10]The Federal Clean Air Act defines a "nonattainment area" as "an area which is shown by monitored data or which is calculated by air quality modeling * * * to exceed any national ambient air quality standard * * * (Sec. 171. (2)).

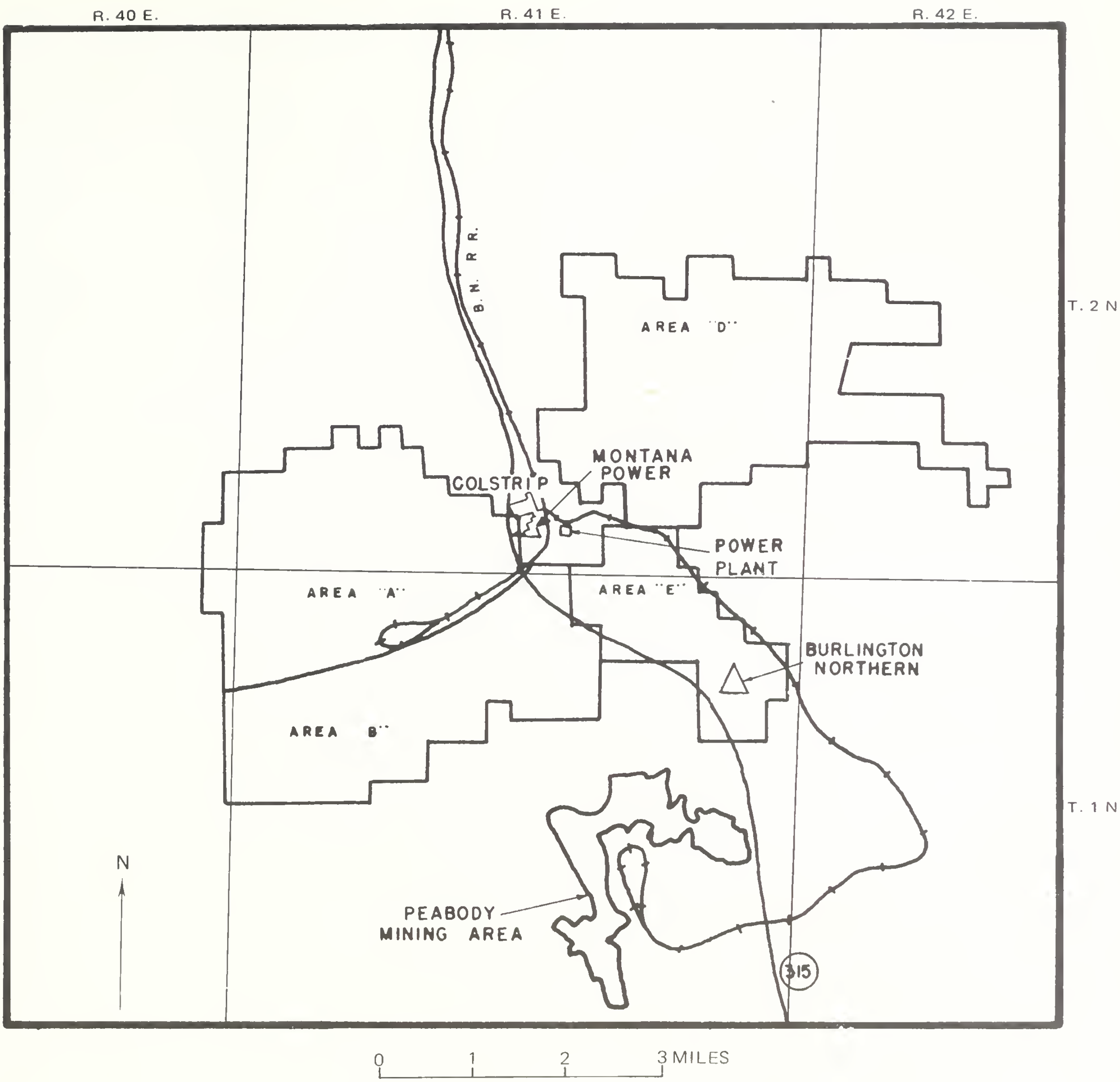

Figure II-11.–Colstrip TSP nonattainment area.

TABLE II-8.--Estimated gaseous emissions related to the Big Sky mine during 1977

[Emission values are in tons per year. Strip-mine-related emissions are based on a coal extraction rate of 2.3 million tons per year]

Source	Number of units/year	CO	NO_x	SO_x	HC	HCN	Aldehydes	Organic acids	All pollutants
Blasting:									
Explosives (ANFO)--	736.766 tons	15.7	1.2	([a])	([a])	0.04	([a])	([a])	16.94
Diesel fuel:									
Heavy duty equipment--------	175,059 gal	8.6	36.7	2.7	3.7	([a])	0.8	([a])	52.50
Gasoline:	12,709 gal								
Heavy duty truck---	113,381 mi	21.7	1.6	0.05	1.7	([a])	([a])	([a])	25.05
Total permit area sources--------------		46.0	39.5	2.75	5.4	0.04	0.8	([a])	94.49
Gasoline:									
Light duty trucks:	7 trucks								
Forsyth to Big Sky------------	145,824 mi	4.3	0.7	0.03	0.4	([a])	([a])	([a])	5.43
Employee vehicles:									
Forsyth to Big Sky------------	312,480 mi	3.1 [b](0.07)	.6 (.01)	.05 ---	0.3 (0.01)	([a])	([a])	([a])	4.05 (0.09)
Colstrip to Big Sky------------	8,184 mi	.09	0.02	---	0.01	([a])	([a])	([a])	0.12
Rural to Big Sky-	496,000 mi	5.2	1.0	0.07	0.5	([a])	([a])	([a])	6.77
Coal trains:	230 trains								
Forsyth to Big Sky-	20,355 mi	57.0 [b](1.3)	161.8 (3.7)	24.9 (0.6)	41.1 (0.9)	([a]) ([a])	2.4 (0.05)	3.1 (0.07)	290.3 (6.62)
Forsyth:									
Population effect--	109 people	37.1	18.5	7.6	14.2	([a])	([a])	([a])	77.4
Total regional sources-------------------		106.79	182.62	32.65	56.51	([a])	2.4	3.1	384.07

[a]Emission factors unknown.
[b]Tons per mile travelled per year.

1) Blasting

Blasting at the Big Sky mine produces nitrogen oxides, carbon monoxide, and hydrogen cyanide. Incomplete combustion of the ammonium nitrate-fuel oil (ANFO) explosive substantially increases these emissions. Moisture in the blast holes, in the form of ammonium nitrate, and the type of explosive initiator affect completeness of combustion. Peabody's use of waterproof explosive bags has prevented the recurrence of acute nitrogen oxide fumigations under wet conditions. Peabody Coal Co. uses ammonium nitrate, although pulverized ammonium nitrate produces a greater explosive yield and lower concentrations of toxic fumes (Van Dolah and others, 1960; Chaiken and others, 1974). In comparison to other initiators, like dynamite C, electric blasting caps used at the Big Sky mine decrease the detonation velocity and increase both CO and NO_x fumes (Van Dolah and others, 1960). The 6-percent fuel oil utilized by Peabody Coal Co. is the recommended mixture for complete combustion and lowest toxic-fume production.

2) Coal fires

Coal fires are a potential source of sulfur dioxide. Coal-seam and spoils-bank fires have occurred in the past, but their frequency and duration are unknown.

E. SOILS

1. The Soils Resource

The soils in the permit area are diverse in origin and character, reflecting development from different parent materials, their topographic position, and age. This diversity reflects a basic stability of soils, plant communities, and animal habitats. Some of the soils in the area are not highly developed. Low precipitation and high summer temperatures limit soil water percolation and nutrient release through mineral weathering. Therefore, vegetative cover is sparser than in a moister climate. Periodically, intense precipitation rapidly erodes great amounts of surface soil from hill slopes. (See Climate and Topography, chapter II.) Eroded soil is redeposited in valley bottoms as alluvium and on hillslopes as colluvium. As a result, soils on steeper slopes and valley bottoms are minimally developed. Soils on steep slopes tend to be shallow and of low productivity, whereas recent alluvial soils are deep and productive. These alluvial soils are a source of high quality "topsoil" material for reclamation.

Soils in the topographically more stable positions (stable uplands gentle footslopes, and adjacent sloping valley bottoms) are more developed. These soils have varying degrees of development in the B

horizon,[11] are highly productive, and have a relatively high use capability classification (table II-9 and appendix E). These soils are generally good sources of "topsoil" material.

2. Soil Series

The company has submitted a soils map (figure II-12) and supporting chemical and physical analyses (table II-9) as part of the mining permit application. Soil profile descriptions and capability group criteria are in appendix E. Soil series description are available from the U.S. Soil Conservation Service.

Within the permit area, the best developed soils belong to the Aridisols Order. They are the Busby, Forelle, and Yamac Soil Series, constituting 5.5 percent of the 1,264-acre permit area. These soils are found in stable topographic positions of less than 8-percent slope, and are in capability Groups III and IV, suitable for use in dryland agriculture, with a significant wind and/or water erosion hazard. Under ideal conditions, these rangelands may produce up to 1,600 pounds per acre of air dry forage. At the present time these and all other soils in the permit area are in rangeland. There is no indication that farming has been practiced within the permit area in the past, although there are dryland and possibly naturally subirrigated fields adjacent to the permit area.

These three soil series are a source of acceptable quality "topsoil" material, suitable for postmining reclamation. However, test results submitted by the company show that, if C horizon materials are placed at, or near, the surface, the calcium:magnesium ratio of the soil solution would be approximately 0.3, a situation which could have negative effects on plant growth. The calcium:magnesium ratios of the "A" and "B" horizons have a combined mean of 1.74, a more suitable condition for plant growth. This relationship, with slightly higher values, is true for other salvageable soils in the permit area.

The textural characteristics of the Aridisols, with a weighted silt and clay fraction of 45 percent, make them relatively more valuable as a "topsoil" resource than other soils in the permit area (39 percent silt and clay). "Topsoil" materials from these soil series would be primarily sandy clay loams, offering somewhat greater resistance to erosion and more plant available water than the sandy loam "topsoil" derived from other soils in the permit area.

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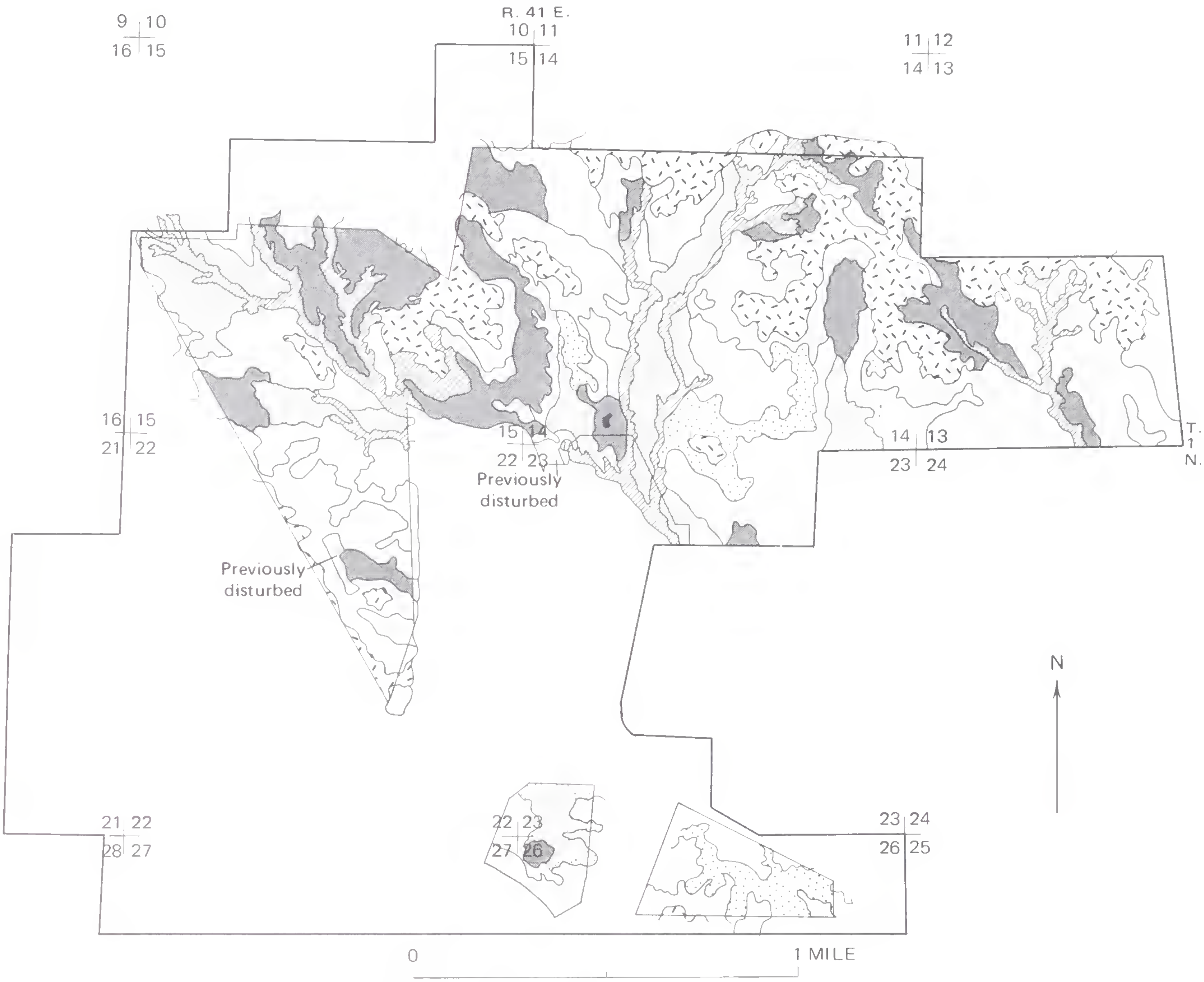
[11] Soil horizons are layers of soil, approximately paralelling the surface, each of which has distinct chemical and physical characteristics, resulting from the development of soil in the geologic parent material over time.

TABLE II-9.--Soil resource characteristics: Big Sky mine permit area

Soil series	Classification	Mapping unit No.	Capability group[1]	Areal extent (acres)[2]	Salvage depth proposed (potential, in inches)
Busby----	Borollic Camborthids, coarse loamy, mixed.	13C	IV e	263	24 (48)
Forelle--	Borollic Haplargids, fine loamy, mixed.	63C	IV e	101.9	30 (60)
Yamac----	Borollic Camborthids.	49C	IV e*	171.2	30 (60)
Lihen----	Entic Haploborolls, sandy, mixed.	2,002	VI e	17.8	24 (80)
Armells--	Ustic Torriorthents, loamy, skeletal, mixed (calcareous), frigid.	125	VII s	71.3	0 (0)
Havre----	Ustic Torrifluvents, fine loamy, mixed, (calcareous), frigid.	400	VII e	102.6	60 (60)
Unnamed--	Ustic Torripsamments, sandy, mixed, frigid.	101	VIII e	198.1	0 (0)
Yawdim---	Ustic Torriorthents, clayey, montmorillon-itic, (calcareous), frigid, shallow.	500	IV e	0	0 (0)**
Yetull---	Ustic Torripsamments, mixed, frigid.	700	VI e	321.2	40 (84)

[1]e: main limitation is risk of erosion.
s: main limitation is soils being shallow, droughty, or stoney.

[2]Error here is due to inherent error in planimetering.
*SCS: III e
**Mapped as a minor inclusion with Yamac. Salvageable to 20 inches when mixed with Yamac.



MAPPING UNIT LEGEND

Mapping Unit	Average Usable Topsoil Depth
Busby fine sandy loam, 2 to 8 percent slopes	24″
Yamac loam, 2 to 8 percent slopes	30″
Forelle loam, 2 to 8 percent slopes	30″
Ustic Torripsamment - Rock Outcrop	0″
Armells channery sandy loam, 20 to 35 percent slopes	0″
Havre loam, 1 to 5 percent slopes	60″
Yawdim loam, 2 to 6 percent slopes	20″*
Yetull loamy sand, 2 to 8 percent slopes	40″
Lihen loamy fine sand, 2 to 8 percent slopes	24″

*If mixed with Yamac

Figure II-12.—Big Sky mine area soils map.

Soil of the Mollisols Order is intermediate in development, characterized in the permit area by a thick (12 inches), dark, organic carbon and base-rich "A" or surface horizon. The one series of this Order is the Lihen soil, occupying 17.8 acres (1.4 percent) of the permit area. Under ideal conditions, this soil will produce up to 2,500 pounds of air-dry forage per acre. Lihen soils are not suited to dryland crop production. This soil, particularly the "A" horizon, is a good source of "topsoil" material.

The remaining soil series are in the Entisols order, characterized by a lack of development. These are the Armells, Havre, Unnamed, Yawdim, and Yetull Series. Within the permit area, these soils are best suited for grazing and wildlife habitat. Potential forage production ranges from virtually zero (Unnamed/rock outcrop complex) to as much as 1,500 pounds per acre (Havre).

The Armells and Unnamed Series are not suited to use as "topsoil" because of high rock content and shallow depth. The remaining Entisols, which occupy 595 acres (47.1 percent of the permit area) have a potential "topsoil" salvage volume of 4,654,592 cubic yards (54.4 percent of total "topsoil" material potential). The quality of this material is somewhat lower than that which could be derived from the Aridisol soils.

The soils suitable for the support of grazing within the permit range from moderate to low in fertility, potentially producing 800-1,600 pounds of dry matter per acre per year as rangeland. However, overgrazing has reduced yields to a range of 500-650 pounds per acre per year.

The potential for "topsoil" salvage within the permit area is high. The total volume (5,303 acre-feet) of "topsoil" material suitable for salvage would cover the 1,264 permit area to an average depth of 50 inches, although not all of the area will need to be topsoiled following mining.

The company's soils consultant based his somewhat more conservative estimate of 2,827 acre-feet (average depth: 27 inches) on field estimates of calcium carbonate levels. Laboratory analyses of the soils indicate that chemical characteristics do not limit the soils as a "topsoil resource."

F. VEGETATION

Grassland, scrub, and forest (fig. II-13) are vegetation communities occurring within the permit area. These communities (for each there are several varieties) are not haphazard in their distribution but are correlated with recurring environmental conditions that tend to form a pattern or mosaic (table II-10). Species lists, range condition, and biomass production tables are presented in appendixes F-1, F-2, K-1, and K-2.

Figure II-13.–Peabody/Big Sky mine site vegetation.

TABLE II-10.--Growth forms and associated vegetation types in the area of proposed mining level disturbance

Growth forms	Vegetation type	Acres[1]	Percent	Dominant soils[2]
Grassland-----	Native grass--------------	420	47	700
Scrub---------	Skunkbush/Grass-----------	95	11	300
	Silver sagebrush/Bench----	85	10	2001, 700
	Big sagebrush/Grass-------	50	6	900
	Silver sagebrush/Coulee---	50	6	400
Forest--------	Ponderosa pine/Grassland--	155	18	300, 400
Sandstone outcrop.	No vegetation-------------	30	3	300
	Total----------------	885	[3]101	---

[1]Rounded to nearest 5 acres.
[2]Soil symbols used by ECON:
300. Yawdim-Rock outcrop association.
400. Alluvial soils.
700. Tullock fine sandy loam.
900. McRae loam, 4- to 10-percent slopes.
2001. Chinook fine sandy loam, 4- to 8-percent slopes.
[3]Error due to rounding.

1. Grassland

The grasslands contain predominantly perennial species, the more common of which are western wheatgrass, prairie junegrass, needle-and-thread grass, and threadleaf sedge. The annuals commonly present in the area are invaders, such as Japanese brome and cheatgrass. The presence of these annuals indicates of a deteriorated range condition, probably resulting from overgrazing.

Three subtypes of the native grass type are represented: western wheatgrass, prairie sand reedgrass, and Sandberg bluegrass/ prairie junegrass. These comprise approximately 89 percent, 10 percent, and 1 percent of the vegetation, respectively.

The western wheatgrass subtype occurs at higher elevations on moderately-deep, medium-to fine-textured soils. Fringed sagewort, salsify, silverleaf scurfpea, and scarlet globemallow are common. Dense stands of yucca occur on some sites of this subtype, and lichens are common.

The prairie sand reedgrass subtype usually occurs in sandy soils near sandstone outcrops and on knolls alongside drainages. Common forbs include blue lettuce, silverleaf scurfpeas, yucca, and milkvetch. No shrubs are considered common in this type.

The Sandberg bluegrass/prairie junegrass subtype is found over a relatively small portion of the area (a total of approximately 20 acres), on benches at lower elevations. Salsify and fringed sagewort are common forbs; the most common shrubs are silver sagebrush and broom snakeweed.

2. Scrub

There are four vegetative types of scrub: skunkbush/grass, silver sagebrush/bench, silver sagebrush/coulee, and big sagebrush/grass. Japanese brome and cheatgrass (annual grasses) are common invaders in each type. The perennial grasses most common to these types include western wheatgrass, needle-and-thread, Sandberg bluegrass, and prairie junegrass.

The skunkbush/grass type generally occurs near stands of ponderosa pine. It is primarily confined to shallow to bedrock soils in drier places. Skunkbush sumac, an important browse species, is the only shrub. Several forbs are common, including sageworts and silverleaf scurfpea.

The silver sagebrush-bench and silver sagebrush-coulee types occupy alluvial flood plains and terraces. The coulee type is distinguished from the bench type by its denser stands of silver sagebrush. Several forbs and perennial grasses are common to both types. In addition, the several weedy species (dandelions, ragweed, and sowthistle) and annual brome grasses present are indicative of disturbed rangelands. This is probably a result of overgrazing.

The big sagebrush/grass type occurs on higher benches and footslopes below steep gumbo ridges. Soils here are clayey and support dense stands of big sagebrush, the only shrub. The most common forbs are Hood's phlox, scarlet globemallow, and salsify.

3. Forest

The ponderosa pine/grassland is the main forest type found in this area. It is usually associated with higher elevations and ridgetops.

Bluebunch wheatgrass and sideoats grama are the dominating perennial grasses. Other species include the shrub, skunkbush sumac, and the forbs, narrow-leafed collomia, and American vetch. This vegetative type occurs on shallow well-drained soils, underlain by fractured bedrock, sandstone, or shale.

4. Threatened/Endangered/Noxious Species

No known threatened, endangered, or noxious species are known to occur in the permit area (appendix F-3).

Five noxious species, however, are known to occur in the Colstrip area: bindweed, Canada thistle, leafy spurge, Russian knapweed, and white top. In the past these species have readily invaded disturbed sites and, therefore, could invade the Peabody site after or during mining.

G. WILDLIFE

Four classes of vertebrates (mammals, birds, amphibians, and reptiles), consisting of 122 species, are known to use the permit area year-round, seasonally, or during migrations (appendix G)[12].

Habitat types identified in table II-11 are those within the permit area that would be lost during mining. Vegetative types combine to form general habitat types, as follows: grassland habitat (western wheatgrass, prairie sand reedgrass, and sandberg bluegrass/junegrass); sagebrush/grassland (big sagebrush/grass, silver sagebrush-bench, and silver sagebrush-coulee); upland shrub (skunkbush/grass); and ponderosa pine (ponderosa pine/grass).

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[12]Studies conducted by Ecological Consulting Service (ECON) from 1973 to 1976 form the basis for this section.

1. Mule Deer

Mule deer are the most abundant big game animals on the minesite. The terrain offers optimum winter range in the form of timbered arroyos, rocky outcrops, and nearby scrubby slopes. However, the permit area lacks a perennial stream and associated riparian habitat that could be used during the dry summer and autumn season. Nonetheless, Rosebud Creek, within 2 miles south of the minesite, offers excellent habitat for these seasons. The mule deer population is nonmigratory because there is considerable overlap of winter and summer ranges. Figure II-14 illustrates habitat used each season by mule deer. Overall, the most important habitat types appear to be ponderosa pine, big sagebrush/grassland and upland shrub. The approximate minimum density of animals was estimated to be 1.6 deer per square mile in 1974 and 3.0 deer per square mile in 1976.

2. Antelope

Only one or two groups of antelope may have home ranges overlapping the minesite. Many of the antelope observed[13] were probably migrating to other areas. Most of the antelope observed use the area during spring or summer migrations. Apparently little or no use of the Peabody study area is made by antelope during the winter period.

3. Small Mammals

Fifteen species of small animals, associated with upland habitats have been identified in the permit area. Cottontail rabbits typically inhabit shrub/grassland vegetation types. Western deer mice and prairie voles are other common species; they prefer skunkbush/grassland, caprock/gumbo knob, and the ponderosa pine/juniper habitats.

4. Raptors

Raptors sighted on the permit area[14] include red-tailed hawks, rough-legged hawks, marsh hawks, and a pigeon hawk. Most raptors were observed over or near the ponderosa pine/grassland habitat type. Many of these birds nest in the surrounding area and may nest in the permit area--all hunt on the permit area. The small American kestrel (sparrow hawk) was very abundant during the spring and summer. A great horned owl nest was discovered in a sandstone cliff near Miller Coulee and a red-tailed hawk nest was found in a cottonwood tree on Rosebud Creek near the mouth of Lee Coulee. This type of habitat exists on the permit area and may contain undiscovered nests.

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[13] Between 1973 and 1976, 207 antelope were observed using the area during spring and summer migrations.

[14] During the 1976 study, 22 raptors were sighted in 20 observations.

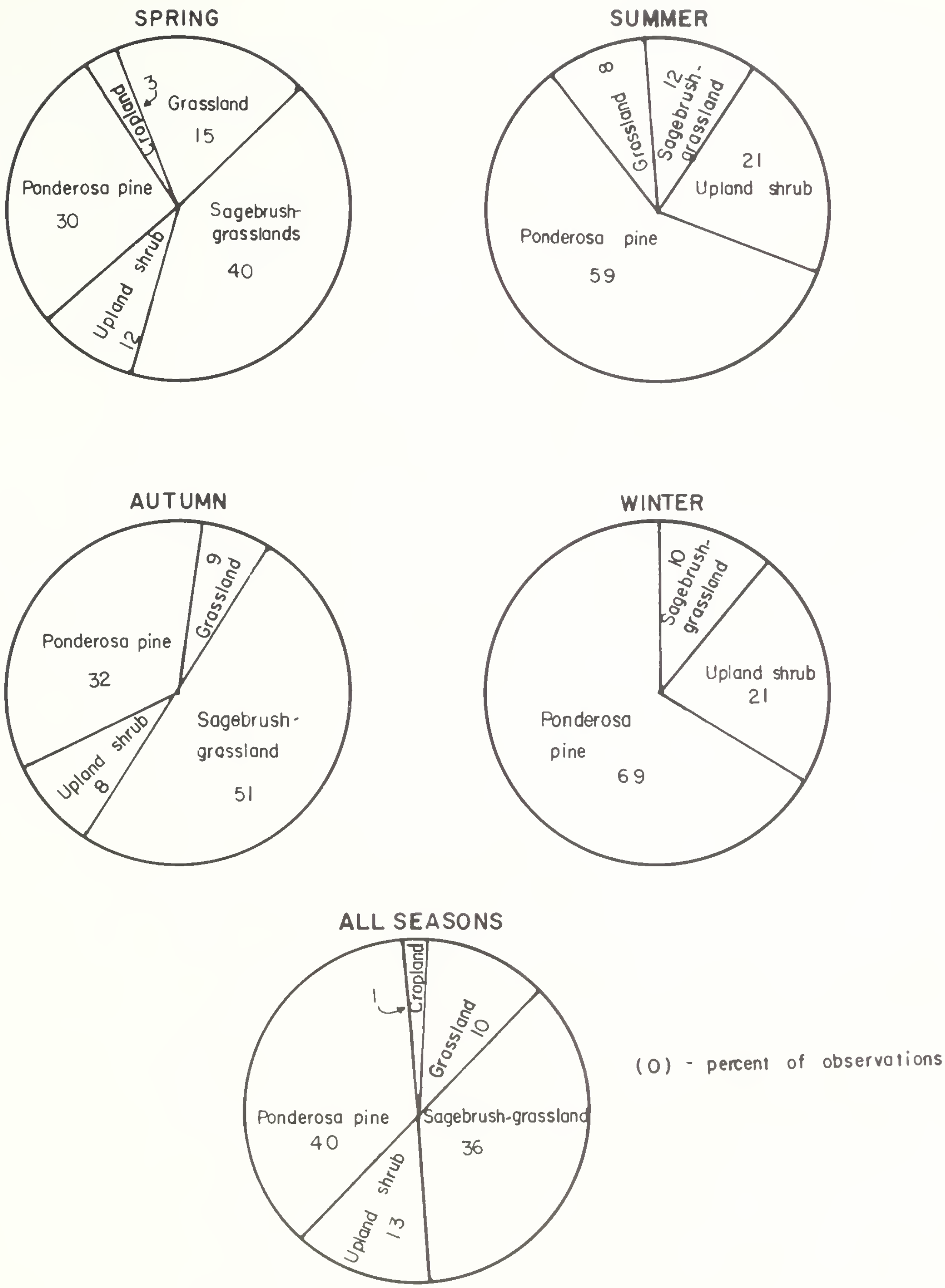

Figure II-14.—Mule deer seasonal habitat use.

TABLE II-11.--Upland terrestrial habitat types within the proposed mine area, Big Sky mine expansion[1]

Type[2]	Acres	Percent
Grassland----------------	639	51
Sagebrush/Grassland------	252	20
Upland shrub-------------	163	13
Ponderosa pine-----------	163	13
Cropland[3]----------------	38	3
Total[4]--------------	1,255	100

[1]Source: Ecological Consulting Service, 1976.

[2]Vegetation types were combined as described on page III-1 of the narrative.

[3]This includes land in section 24, which has subsequently been dropped from the permit application.

[4]Error due to rounding.

Golden and bald eagles and prairie falcons have been observed in the vicinity of the mine, but there are no known nests in the permit area. Prairie falcon nests are probably located on the permit area among the rock outcrops shown in figure II-15.

5. Upland Game Birds

Game birds associated with upland habitats of the Peabody area are sharptailed grouse, sage grouse, and Hungarian partridge. Sharptailed grouse is the predominant game bird. In 1975 and 1976 an estimated 2.5 birds occurred each square mile. This estimate may be low, because studies in the similar Colstrip vicinity provided higher estimates.

The Peabody area has been classified as prime sharptailed grouse habitat in the Northern Powder River Basin coal region.[15] Sharptails appear to be generally distributed throughout the Peabody area, with the high ridges on the north and west borders appearing to receive the greatest use. In general, sharptails on the Peabody area appear to prefer the

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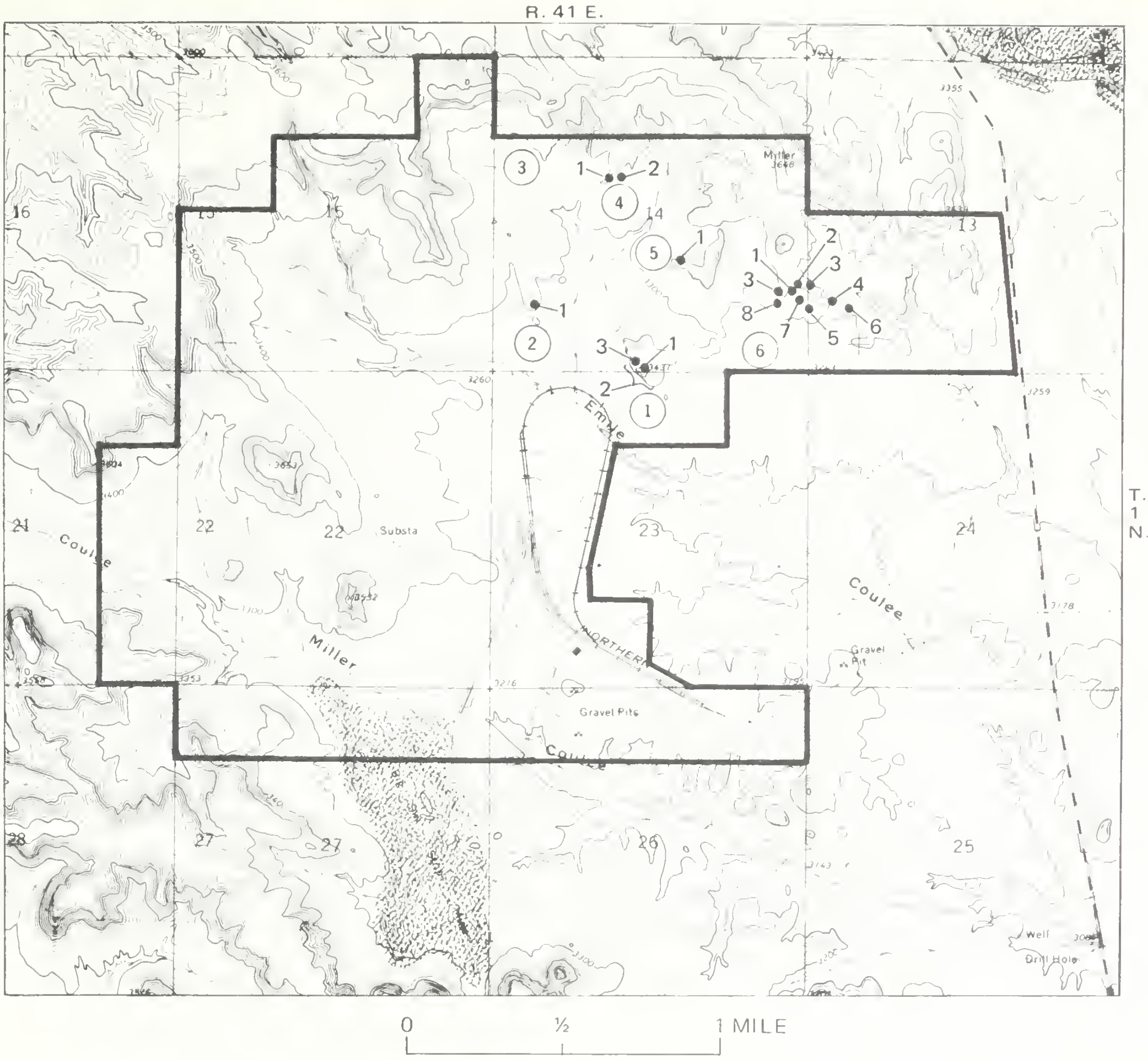
[15]Cooperative U.S. Fish and Wildlife Service/Montana Department of Fish and Game: Terrestrial Wildlife Habitat Ranking contracts to be published by F.W.S. in 1978.



NEST SITES

(1) ROCK OUTCROP NO. 1

1 Great Horned Owl nest site (cavity in sandstone)
2 Cliff Swallow colonies (southwest faces of sandstone)
3 Lark Sparrow nest, two young, (under skunkbush plant)

(2) ROCK OUTCROP NO. 2

1 Song Bird nest, species unknown

(3) ROCK OUTCROP NO. 3

None observed

(4) ROCK OUTCROP NO. 4

1 White Throated Swift nest site (cavity in sandstone)
2 Lark Sparrow nest site (three eggs, under skunkbush plant)

(5) ROCK OUTCROP NO. 5

1 Possible Prarie Falcon nest

(6) ROCK OUTCROP NO. 6

1 Golden Eagle nest, old and abandoned (on sandstone ledge)
2 Raptor nest, species unknown, possibly a Red-Tailed Hawk (ledge)
3 Sparrow Hawk nest (cavity in sandstone)
4 Possible Praire Falcon nest
5 White Throated Swift colonies 15-20 nests
6 Violet Green Swallow nest
7 Rock Wren (feeding young, nest assumed nearby)
8 House Wren (flying brood, nest assumed nearby)

Figure II-15. Location and identification of bird nests on or near Peabody permit area.

silver sagebrush/grassland, upland shrub, grassland, and ponderosa pine habitats. Shrubs (prairie rose hips and skunkbush sumac) were determined as the most important forage class in the sharptail diet (81 percent). Winter observations indicate some preferences for creek bottom and cropland habitats, in addition to those previously identified.

Three sharptail display grounds (leks) were located, one of which became inactive in 1976. None are within the area to be mined, although the most recently discovered lek is not more than one-half mile from the proposed mine.

Hungarian partridge occur in small numbers, although the Peabody area is not optimum "hun" habitat. In general, preferred habitats for this species are upland shrub, grasslands, and ponderosa pine.

6. Songbirds

Small nongame birds commonly migrate through the area during spring and fall. Additionally, many are common nesters in the Peabody and Colstrip areas. Horned larks and western meadowlarks are common year-round in the open shrub/grasslands. Brewer sparrows occur in the Peabody area and are highly dependent upon sagebrush/grasslands, nesting exclusively in big sagebrush. Both eastern and western kingbirds are commonly observed after the emergence of flying insects in early summer. Tree sparrows, mountain bluebirds, and pinyon jays were commonly observed in association with the ponderosa pine/grassland type. Mourning doves commonly nest in ponderosa pines. Many of these birds nest among the outcrops shown in figure II-15.

7. Reptiles

The prairie rattlesnake and the bullsnake are relatively abundant on the Peabody area, and racers have been seen. The study area is near the edge of the sagebrush lizard's normal range. It has been sighted in the area's steep sandstone breaks.

8. Fisheries

There are no significant fisheries or aquatic habitat on the permit area.

9. Endangered Species

Because eagles have been observed in the area, clearance must be obtained from the Fish and Wildlife Service prior to mining.

H. SOCIOLOGY

Rosebud County is primarily an agricultural area composed of rich farming and ranching lands. The county has been long recognized for its coal mining potential. In 1924 Northern Pacific Railroad opened a small mine at Colstrip to supply its coal-powered trains. The mine closed with the conversion to diesel-powered trains. With the recent nationwide in increase in demand for coal, mining activity in the county has increased. The Northern Cheyenne Indian Reservation is a large part of the county, and, because of its different culture and history, complicates the existing social and economic mosaic.

1. Population

Population in Rosebud County has fluctuated in response to both the demand for coal and the agricultural market. Prior to the 1970's, population tended to decline (table II-12). In the 1930's emigration transpired mainly because of drought conditions and the advent of agricultural mechanization. As the population decreased the proportion of nonfarm, nonwhite, female, and elderly people in the country increased. With the reopening of the Rosebud mine and the opening of the Big Sky mine in the late 1960's, this trend began to reverse. Population probably peaked during the construction of Colstrip generating units 1 and 2. A 1976 special census indicated that 9,518 people resided in Rosebud County at that time (table II-13). Since then the population has declined slightly--to approximately 8,523 people. The Northern Cheyenne Indian Reservation accounted for approximately 20 percent of the county's population in 1950 This figure rose to 30 percent in 1970 and has probably decreased until 1975.

From 1970 to 1976 the median age of the county's population decreased to 27.6, slightly lower than both State and national norms. In-migration during this period resulted in slightly higher birth rates and increased school enrollment. The net effect of out-migration since 1976 has probably been to equalize the proportion of males and females in the county and to increase, again, the proportion of nonwhites in the county's population.

Many of the new workers employed in the mining industry have come from outside Rosebud County, but many are from Montana. Of the present employees at the Big Sky mine, 80 reside within the county: 4 at Ashland, 10 at Colstrip, 56 at Forsyth, and 10 at Lame Deer. One mine worker lives in Hysham and one in Ashton, S. Dak.

2. Social Structure

Social structure refers to the formal and informal associations that develop in communities to satisfy collective goals. These associations are excellent indicators of community values, because they represent activities and objectives deemed important by the community.

TABLE II-12.--Population by urban-rural, race, sex, and age Rosebud County, Montana, 1950, 1960, and 1970

[Source: U.S. Department of Commerce, Bureau of Census]

	1950	1960	1970	Percentage of change 1950-70
Total population-----	6,570	6,187	6,032	-8.19
Urban----------------	0	0	0	0.00
Rural----------------	6,570	6,187	6,032	-8.19
Farm---------------	2,428	1,559	1,512	-37.73
Nonfarm------------	4,142	4,628	4,520	9.13
Race:				
White--------------	5,228	4,854	4,203	-19.61
Nonwhite-----------	1,342	1,353	1,829	36.29
Indian-----------	NA	1,344	1,820	---
Other------------	NA	9	9	---
Sex:				
Male---------------	3,560	3,201	3,051	-14.30
Female-------------	3,010	2,986	2,981	-.96
Age:				
Male---------------	3,560	3,201	3,051	-14.30
Less than 5------	432	419	298	-31.02
5-17-------------	803	904	918	-14.32
18-64------------	2,027	1,526	1,531	-24.47
65 plus----------	298	352	304	2.01
Female-------------	3,010	2,986	2,981	-.96
Less than 5------	408	387	311	-23.77
5-17-------------	724	859	864	19.34
18-64------------	1,660	1,449	1,496	-9.88
65 plus----------	218	291	310	42.20
Total:				
Less than 5------	840	806	609	-27.50
5-17-------------	1,527	1,763	1,782	16.70
18-64------------	3,687	2,975	3,027	-17.90
65 plus----------	516	643	614	18.99

TABLE II-13.--Population comparisons by race, sex, and age Rosebud County, Montana, 1970 and 1976

[Source: U.S. Department of Commerce, Bureau of Census]

	1970	1976	Percentage of change 1970-76
Total population------	6,032	9,578	+58.8
Race:			
White---------------	4,208	7,429	+76.5
Nonwhite------------	1,829	2,149	+17.5
Indian------------	1,820	2,145	+17.9
Other-------------	9	4	-55.6
Sex:			
Male----------------	3,051	5,121	+67.8
Female--------------	2,981	4,457	+49.5
Age:			
Male-----------------	3,051	5,121	+67.8
Less than 5--------	298	483	+62.1
5-17---------------	918	1,314	+43.1
18-64--------------	1,513	3,062	+100.1
65 plus------------	304	262	-13.8
Female---------------	2,981	4,457	+49.5
Less than 5--------	311	483	+55.3
5-17---------------	864	1,228	+42.1
18-64--------------	1,496	2,451	+63.8
65 plus------------	310	295	-4.8
Total----------------	6,032	9,578	+58.8
Less than 5--------	609	966	+58.6
5-17---------------	1,782	2,542	+42.6
18-64--------------	3,027	5,513	+82.1
65 plus------------	614	557	-9.3

a. Colstrip

Colstrip has a weak sense of community, this is due to members having little or no development of dependence on the community for shopping services and little or no development of tradition. There are few formal associations in Colstrip, due to the relative newness of most residents and the fact that it is an unincorporated town. Three churches, the public school, and a recreation program are the only major sources of associations.

Newcomers to the community are accepted into formal structures first. Some newcomers, particularly those whose lifestyles and values are similar to those of the indigenous population, apparently are becoming integrated into the community. Gold (1974) suggested that such persons, as they assume future positions of community leadership, may become catalysts of social change. As yet, newcomers have not assumed formal positions of leadership.

b. Forsyth

Forsyth has a strong sense of community, as indicated by the presence of more formal and informal organizations and associations. Most formal organizations in Forsyth were formed years ago and consequently reflect many of the values characteristic of an agrarian way of life--a strong sense of independence and privacy in personal and business matters. Such values continue to influence many of the key formal organizations, thereby interfering with the community's ability to adapt to many of the changes associated with coal development.

This agrarian way has become evident from the behavior of many local businessmen: the commercial service of the community may have become over-expanded as each businessman has pursued his independent course of action. Accordingly, many Forsyth businessmen would welcome additional population to provide customers for their over-expanded commercial services.

As in Colstrip, newcomers to Forsyth do not hold positions of leadership, indicating that they have not yet become highly integrated into the formal structure of the town.

c. Ranchers

According to Gold (1974), Rosebud County ranchers have a highly interdependent social system. Even so, they do not have a collective sense of "where they stand" because of their hesitancy to communicate freely with one another. This lack of communication tends to interfere with attempts to organize an opposition to coal development.

Traditionally, Rosebud County ranchers have been very influential in local government affairs. According to Gold, however, many are now feeling a loss of control and a reduced sense of influence. Although elective positions are still held by old timers, area ranchers apparently are fearful that individuals having procoal development attitudes will gain elective office and that area ranchers will no longer control local decision making processes.

Unlike ranchers in Wyoming, ranchers in Montana, according to Gold, view ranching as a way of life threatened by coal development. However, their desire for independence and privacy interferes with their efforts to collectively oppose coal development.

I. ECONOMICS

1. Introduction

Rosebud County has been undergoing economic changes for the past decade due to coal development. Although coal mining has existed in the county since 1924, the economy has been based primarily on agriculture, with ranching units predominating. In many instances, family ranches have been held for several generations. Some cropland production complements the ranching operations.

With the expansion of coal mining and the construction of the electrical generating units at Colstrip, new employment and population characteristics have emerged in the county, and business activity has increased. Although the mining and construction activities have been concentrated in Colstrip, the commercial activity there is underdeveloped Colstrip has had difficulty in attracting investors in retail business. For example only half the available space in the shopping mall owned by Western Energy Co. is occupied. There are approximately 12 commercial businesses in Colstrip. In comparison, 46 businesses have opened or expanded in Forsyth since 1970, leaving only a few stores vacant.

2. Employment

Individuals living in Rosebud County have historically depended upon agriculture for their livelihood, either directly or indirectly. With coal development, the labor force increased approximately 68 percent between 1970-75 (table II-14). Between 1950 and 1970, total employment had declined, as had population. Between 1970 and 1975 the number of farm proprietors decreased slightly while nonfarm proprietorship increased. The number of farm workers remained the same while the number of government workers increased and the number of private nonfarm workers increased substantially. The mining sector increased as Western Energy's Rosebud mine and Peabody's Big Sky mine commenced operations in the late 1960's. With the building of Colstrip Generating Units 1 and 2 (1973-75) the construction sector increased

Table II-14.--Employment by type and industrial sector, 1970 through 1975, Rosebud County, Montana

[Source: U.S. Department of Commerce, Bureau of Economic Analysis. D, Information unobtainable from the indicated industries because of disclosure protection provided by law]

Classification	1970	1971	1972	1973	1974	1975
Total employment	2,550	2,792	2,984	3,229	3,513	4,279
Number of proprietors	732	737	744	738	731	715
Farm	423	417	410	404	396	379
Nonfarm	309	320	334	334	335	336
Wage and salary employment	1,818	2,055	2,240	2,491	2,782	3,564
Farm	263	292	293	292	319	270
Nonfarm	1,555	1,763	1,947	2,199	2,463	3,294
Government	439	462	474	517	567	647
Total Federal	108	111	119	119	138	154
Federal civilian	108	111	119	119	138	154
Military	0	0	0	0	0	0
State and local	331	351	355	398	429	493
Private Nonfarm	1,116	1,301	1,473	1,682	1,896	2,647
Manufacturing	D	D	D	192	180	142
Mining	D	D	D	269	281	393
Construction	29	25	39	76	180	772
Transportation, communications, public utilities	207	181	192	189	205	218
Trade	212	242	268	311	344	426
Finance, insurance, real estate	19	26	37	D	D	D
Services	387	514	562	596	651	630
Other	6	5	6	D	D	D

sizably. Employment peaked in 1975 at 4,948[16] and dropped to 4,467 by 1977.

Table II-15 shows comparative contributions of total employment for Rosebud County, the State of Montana, and the nation as a whole. Overall farm employment in Rosebud County generally exceeds that of the State and the country. Rosebud County is less concentrated in the private nonfarm sector than the U.S. and is approximately the same as the State as a whole. Manufacturing is small, but mining in the county far exceeds both the State and nation. Construction is higher in Rosebud County due to coal-production activity and highway construction.

TABLE II-15.--Sector employment: comparative distribution analysis Rosebud County-State of Montana and the United States, 1975

[Data are in percent]

	Rosebud County	State of Montana	United States
Total employment	100.0	100.0	100.0
Farm proprietors	8.8	8.2	3.2
Nonfarm proprietors	7.8	10.1	7.3
Farm	6.3	4.0	1.2
Government	15.1	20.5	16.8
Private nonfarm	61.8	57.0	71.5
Manufacturing	3.3	7.6	21.3
Mining	9.1	2.3	.7
Construction	18.0	4.3	4.2
Transportation, communication, public utilities	5.0	6.0	5.0
Trade	9.9	18.2	18.2
Finance, insurance, real estate	D[1]	3.0	4.2
Services	14.7	15.2	16.8
Other	D[1]	.3	.3

[1]D, Information unobtainable for the indicated industries because of disclosure protection provided by the law.

Currently the Big Sky mine employs 82 people (management and operational workers). Seventy-two of the operational workers are members the United Mine Workers Union; the remainder are nonunion. Wages are set according to union contract.

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[16]Montana Employment and Labor Force, Monthly Report: Helena, Montana, Employment Security Division, Department of Labor and Industry, v. 5, nos. 1-12.

Unemployment characteristics for Rosebud County for the years 1971-77 are shown in table II-16. Construction activity and seasonal variations have caused some fluctuations in the unemployment rate. Indian unemployment is also reflected here and is usually substantially higher than representative State or National figures.

TABLE II-16.--Labor force, employment and unemployment, 1971-77, Rosebud County

[Source: Montana Employment and Labor Force, Monthly Report: Helena, Montana, Employment Security Division, Department of Labor and Industry, vols. 1-7, nos. 1-12]

	1971	1972	1973	1974	1975	1976	1977
Labor force-------	2,768	2,707	3,195	3,294	5,169	4,575	4,747
Employment--------	2,663	2,596	3,065	3,139	4,948	4,238	4,467
Unemployment------	105	111	130	155	221	337	280
Rate of unemployment (percent)--	3.8	4.1	4.1	4.7	4.3	7.4	5.9

3. Income

New sources of income generated from mining have decreased the county's dependence on agriculture. This income has resulted in new retail activity in Forsyth and in new housing and business in Colstrip, further diversifying the county's economy. As a result, job opportunities have improved for people in the area.

During the period 1970-75, total earnings for Rosebud County increased annually (table II-17). Because of the rapid growth of energy and related developments, agricultural earnings declined in relative importance, whereas private nonfarm earnings increased. This was due primarily to temporary construction activity at Colstrip. Agriculture, however, remains an important source of base income and is comparable to many of the individual private nonfarm sectors.

Per capita personal income (table II-18) grew by approximately 55.8 percent between 1970 and 1975--higher than in both the State and national figures; however, the per capita income growth rate has remained lower. In 1970 approximately one-fourth of Rosebud County's population was considered to be at or below the poverty level. Much of this can be attributed to the low income of Indians. Historically, income in Forsyth has been increasing at a more rapid rate than that of the county. No income data are available for Colstrip; however, income there is believed to be considerably greater than at the county level.

TABLE II-17.--Personal income[1] by major sources for Rosebud County: 1970, 1975 (thousands of dollars)

[Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. D, Information unobtainable from the indicated industries because of disclosure protection provided by law. L, less than ±0.1]

	Rosebud County		Rosebud		Montana		U.S.	
	Amount		Percentage distribution					
	1970	1975	1970	1975	1970	1975	1970	1975
Total personal income------------	19,806	43,693	100	100	100	100	100	100
Property income---	2,914	4,801	14.7	11.0	15.7	15.6	14.4	13.6
Transfer payments-	2,189	4,170	11.1	9.5	10.4	12.8	9.8	14.3
Farm earnings-----	4,499	4,116	22.7	9.4	13.2	12.5	2.5	2.3
Nonfarm earnings--	9,935	38,380	50.2	87.8	64.1	63.4	76.6	73.9
Government earnings------	2,564	5,131	12.9	11.7	15.9	16.1	14.0	13.9
Total federal-	1,046	2,118	5.3	4.8	6.8	6.3	5.7	4.8
Federal civilian--	962	1,953	4.9	4.5	4.4	4.4	3.6	3.3
Military----	84	165	0.4	0.4	2.4	1.9	2.1	1.4
State and local-------	1,518	3,013	7.7	6.9	9.1	9.7	8.3	9.1
Private nonfarm---	7,371	33,249	37.2	76.1	48.2	47.3	62.7	60.0
Manufacturing---	D	1,038	D	2.4	8.1	7.0	22.0	19.2
Mining----------	D	7,638	D	17.5	2.6	2.8	0.8	1.1
Contract construction--	329	13,894	1.7	31.8	5.1	4.9	4.8	4.4
Transportation, communications, public utilities----------	1,720	2,865	8.7	6.6	6.8	6.7	5.6	5.6
Wholesale and retail trade--	1,190	2,879	6.0	6.6	12.5	12.7	13.1	12.9
Finance, insurance, real estate--------	150	D	0.8	D	2.8	2.7	4.1	4.0
Service---------	2,046	4,285	10.3	9.8	10.0	10.1	12.0	12.5
Other-----------	198	D	1.0	D	0.3	0.3	0.2	0.3
Less social insurance-------	-613	-2,543	-3.1	5.8	-3.4	-4.2	-3.5	-4.0
Residence adjustment------	882	-5,231	4.5	-12.0	-0.1	L	L	L

[1]Current income from all sources, measured after deduction of personal contribution to Social Security, government retirement, and other social insurance programs but before deduction of income and other personal taxes.

TABLE II-18.--Per capita personal income, in dollars, 1970 and 1975

	1970	1975	Percentage of change
Rosebud County----	$3,266	$5,088	55.8
Montana-----------	3,500	5,433	55.2
United States-----	3,966	5,903	48.8

The most recent census data indicate that 20 percent of the families in Rosebud County and approximately 25 percent of the individuals have incomes below the poverty level.

Sources of agricultural income for the years 1970-75 are shown in table II-19. Livestock is the major source, although crops have become increasingly important.

TABLE II-19.--Cash receipts (in dollars) from sale of principal products and government payments, 1970 through 1975, Rosebud County, Montana

[Source: Montana Agricultural Statistics, Vol XIV to Vol. XVI, County statistics 1970-71 to 1974-75, Montana Department of Agriculture and Statistical Reporting Service, USDA]

Year	Livestock and products	Crops	Receipts from marketing	Government payments	All cash receipts	Cash receipts per farm
1970---	8,810,000	2,279,200	11,090,000	883,000	11,973,000	28,900
1971---	10,905,200	1,789,400	12,694,000	698,000	13,392,600	32,232
1972---	12,664,500	2,499,500	15,164,000	847,200	16,011,200	40,123
1973---	15,075,400	4,475,500	19,550,900	462,000	20,012,900	50,923
1974---	13,673,900	7,588,000	21,261,900	198,400	21,460,300	60,622
1975---	12,186,700	6,073,000	18,259,700	159,100	18,418,800	54,494

4. Tax Structure, Revenues and Expenditures

The general sources of tax revenue for the State of Montana are:

General Tax Structure for Montana

a.	Property taxes	b.	Personal income tax
c.	Corporation income tax	d.	Highway users tax
e.	Alcoholic beverage tax	f.	Tobacco taxes
g.	Insurance tax	h.	Mineral resource taxes
i.	Inheritance tax	j.	Unemployment compensation tax

The permissive district levy, voted levies, and the foundation program fund education in Montana. Local unvoted levies cannot exceed the State-specified permissive budget, and the foundation program controls the transfer of funds to and from school districts. Deficiencies in financing are made up by the State, and any excess generated by the school district goes to the State. As the school district finds it necessary to exceed the permissive budget (i.e., for capital improvements), the additional funds must come from voted levies. Forsyth school district is at the maximum levy and is dependent upon intergovernmental transfers and voted levies for its basic operation. Colstrip, by comparison, has a very low mill levy, sends funds to the State, and is not in need of intergovernmental transfers. For purposes of financing highways, roads, and streets, the State relies on fuel taxes, property taxes, special improvement taxes, vehicle registration, gross vehicle weight tax, coal severance tax, and federal funds. Property taxes produce over 50 percent of State and local revenues, followed in percentage by individual income taxes, the motor fuel tax, corporate licenses, and natural resource taxes. There is an increasing tendency to depend upon the coal severance tax for revenues; however, these funds will not be available after 1980.[17]

State and county tax jurisdiction and detailed accounts of tax levies, revenues, and valuations of Rosebud County (1970-76) are presented in appendixes I-1, I-2, and I-3.

The impacted area relies on property taxes as the basic source of revenue. Individual income tax (18.2 percent), motor fuel tax (7.7 percent), natural resource tax (6.3 percent), coupled with property tax (52.3 percent) accounted for 84.5 percent of the tax revenue of Montana in 1976. Montana tax laws establish mill limits relative to State and county property taxes.

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[17] For more detailed information concerning Rosebud County and Montana taxes, see appendix I-4.

The assessed and taxable values in Rosebud County have increased considerably from 1970 to 1976. Assessed value of land has increased less than $1 million during this period while the assessed value of improvements increased $83 million from 1975 to 1976, with the majority of this increase attributable to locally-assessed utilities, gross proceeds, net proceeds, royalties, and mining machinery The total taxable value increased $27.9 million from 1975 to 1976.

Property tax mill levies by school district and by types of levy have decreased in most Rosebud County districts from 1969-70 to 1977-78. The Forsyth School District levies, however remain quite high. The decrease in county levies is due to the tax base provided by Colstrip generating units 1 and 2, the Rosebud mine, and the Big Sky mine. Receipts and expenditures have increased considerably for the County Commission, with increases due to transportation, education, and general government activities.

A time-adjustment problem exists at both the county and town level in that demand for services precedes the revenue to provide such services. Undoubtedly the grants and loans to both levels provide the essential revenue that allows the financial aspects for each governmental unit to continue operating on a sound basis.

J. COMMUNITY SERVICES

Community services in Rosebud County have been impacted by the opening of the Rosebud and Big Sky mines and by the construction and operation of Colstrip Generating Units 1 and 2. The demand for services has declined from peak levels (1973-75), allowing the county to catch up to some extent. Funding from sources outside the county (table II-20) has also provided for the expansion of services, further enabling the county to meet the demand.

1. Housing

A total of 973 additional homes, including mobile homes and trailers, were added to the Rosebud County housing stock between 1970 and 1977. Most of this growth occurred in Forsyth and Colstrip. In April 1978 estimates of existing housing were made for these two towns (Meadowlark, 1978):

Type of dwelling	Forsyth	Colstrip
Single-family---------	594	207
Apartments------------	62	64
Mobile homes----------	256	393
Total---------------	912	664

TABLE II-20.--Rosebud County municipal projects

Project	Financing	Capacity	Source of funding
Rosebud County jail---	$100,000	24 persons	Montana Coal Board
Forsyth water treatment.	$1.35 million	22,000 persons (3.5 Mgpd)	Montana Coal Board Farmers Home Administration
Forsyth waste water treatment.	$290,000	5,000 persons	Environmental Protection Agency Montana Coal Board
Lame Deer-------------	Being planned (25-acre oxidation-ditch treatment plant)		
Forsyth school program.	$2.5 million Unknown $27,000	K-5 (new)* 6-8 (new)** 9-12 modifications	Montana Coal Board Unknown Montana Coal Board
Colstrip school program.	$450,000 $317,000	Elementary classrooms 9-12 remodelling	Montana Coal Board Montana Coal Board
Three-county solid waste.	$289,000	Planning and implementation	Montana Department of Health and Environmental Sciences Montana Coal Board

*To open in 1979.
**To be completed in the fall of 1978.

The county underwent a period of urbanization that was primarily caused by in-migration associated with the energy boom. Until recently, immigrants have had difficulty acquiring housing, even though, between 1970 and 1976, the county's housing stock increased faster than the population. The county vacancy rate dropped to 1.3 percent (lower in impacted areas; 5 percent is considered to be desirable). By 1976 the vacancy rate was back to 5.2 percent (John Short and Associates) and has since stabilized.

Low-cost housing in Rosebud County is generally unavailable, making matters difficult for low-income people; it also makes those who rent vulnerable to displacement as housing costs rise. Older people with homes too large and difficult for them to manage are discouraged from selling. This, in turn, reduces the availability of housing to new people moving into the area.

Forsyth's existing townsite has the capacity to absorb approximately 1,200 more people.[18] Colstrip could absorb up to 5,000 additional temporary and 3,000 permanent people if the townsite expanded.

Approximately 200 new housing units are currently needed on the Northern Cheyenne Reservation in addition to 584 units of HUD public housing.

Housing conditions throughout the county vary, since most homes are either more than 30 or less than 5 years old. In 1975 the physical condition of 90 percent of the county's single-family dwellings was rated as below average or worse (Rosebud County Situation Statement). The Rosebud County Housing Assistance Plan (1975) reported that more than half the housing units were substandard (appendix J-1).

Modular homes have a life expectancy of about 75 years, while mobile homes are expected to last only 20 years (HUD). Unless the mobile home stock in the county is replaced by more permanent housing, Rosebud County may lose roughly one-third of its stock in the 1990's due to structural obsolescence. In addition, mobile-home depreciation would adversely affect local tax bases.

2. Water

Water systems include: water supply, storage, treatment, and distribution. The Yellowstone River and private wells are the water sources for Rosebud County. Several recent projects have upgraded systems within the county (table II-20). The entire system in Forsyth appears adequate for projected growth (appendix J-2). In Colstrip, the system is at capacity,

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[18] Assume that an average family of 2.67 people builds a single-family home on each of the 330 vacant lots in Forsyth and that 420 persons would fill all the temporary housing (Meadowlark Group, 1978).

and expansion is being planned. If completed, the entire system should be adequate for anticipated demands. Lame Deer has an adequate supply; however, improvements are needed for water storage and storm drainage. The flooding in May, 1978 contaminated the community water supply.[19]

3. Wastewater Treatment

Rosebud County is served by a combination of municipal and private waste-water systems. The waste-water system in Forsyth is currently inadequate. It is designed to service a population of 800, approximately 1,500 less than the existing population. A new treatment plant, which would remedy this situation, is expected to be completed by June 1979 (table II-20). Improvements are underway on the Colstrip system, which, once completed, will be sufficient to meet projected population levels (appendix J-3). Lame Deer is also planning a new treatment plant due to the poor condition of the existing system, but funding and construction have not yet begun.

4. Solid Waste

Rosebud County is developing a joint solid-waste program with Big Big Horn and Treasure Counties. Under this system several existing dumps are being phased out and a network of containers is being installed. These containers will be dumped at a central landfill near Vananda, north of the Yellowstone River. Rosebud County facilities will include a 75-cubic-yard container with a compacter in Forsyth, and a 40-yd^3 container at each of the following sites: Ingomar, Rosebud, Birney, Ashland, and two rural locations. Colstrip will continue using its licensed landfill, while the Indian Action Team and the Bureau of Indian Affairs (BIA) will continue serving the solid-waste needs of Lame Deer.

5. Schools

School facilities and statistics are summarized in table II-21. Forsyth is completing a building program (table II-20) which includes a new elementary and junior high or middle school. The school district expects to have adequate capacity for increased enrollment. An old elementary school is available for extra space, should it become necessary.

The Colstrip District is also completing a building program, and now has 13 temporary mobile classrooms that are unused. The district is not planning any further construction.

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[19]Meadowlark Group, 1978. Report to the Department of State Lands on the Social and Economic Impact of the Big Sky mine expansion.

The Lame Deer school district lacks adequate facilities and funding for the existing enrollment. The primary reason for this is the small tax base provided by the few private holdings within the Reservation. The Reservation properties are tax exempt, and the school, as a public school, is ineligible for BIA funding, despite the fact that the majority of the students are Northern Cheyenne. The school needs five more classrooms and a gym to meet the demands of the present enrollment.

TABLE II-21.--Rosebud County schools, 1977

	Number of class-rooms	Schools with gym	Number of multi-purpose rooms	Student enroll-ment	Number of teachers	Stu-dents/ class-room	Stu-dents/ teacher
Forsyth:							
Jr. High 7-8-----	6	---	1	111	6.9	18.5	16.0
High School 9-12-	16	1	1	235	14.6	14.6	16.0
Elementary K-6---	19	(*)	1	471	29.9	24.7	15.7
Colstrip:							
High School 9-12-	13	---	2	198	17.2	15.2	11.5
Elementary K-8---	15	---	1	399	19.8	26.6	20.2
Lame Deer K-8------	16	---	1	383	25.0	23.9	15.3
Rosebud K-12-------	12	1	1	177	15.0	14.7	11.8
Four rural elementary K-8---	10	1	4	139	9.3	13.9	14.9

*Elementary school gym classes are held in the high school gym.

6. Libraries

The Rosebud County Library is located in Forsyth and conforms to the facility and service standards of the Montana State Library Commission. The Library has a bookmobile service and has access to the Miles City Public Library, as well as having teletype service to numerous State, University, and public libraries associated with the Pacific Northwest Bibliographics Center in Seattle, Washington. The bookmobile stops in Colstrip and eight other county locations but, due to population size, is insufficient to meet the current needs of the Colstrip population.

7. Law Enforcement

Law enforcement in Rosebud County and Forsyth is a function of a consolidated force under the direction of the County sheriff. The Sheriff's Department has a staff of 23 officers: 8 are specifically assigned to Forsyth, 3 to Colstrip, 2 to Ashland, and 1 to Birney.

The 11-member tribal police force stationed in Lame Deer has responsibility for the entire reservation. Although their jurisdiction is restricted to Indian people, non-Indians may be detained until transferred to authorized county law-enforcement officials.

In 1976 Rosebud County had a crime rate of 3.1 per 100 persons, higher than that of adjacent coal impacted counties, but still below the State average of 4.3. Appendixes J-4 and J-5 give a breakdown of crime statistics within Rosebud County.

Energy resource development appears to have had a substantial effect on expenditure trends. At the county level, 16.4 percent of the general fund for 1978 (appendixes J-6 and J-7) has been allocated for the Sheriff's Department and 13.2 percent of the municipal fund has been allocated. This is up from 14.4 percent and 9.8 percent, respectively, from 1976. Law enforcement demands appear to be rapidly increasing in rural areas of the county and have risen more sharply for the whole of Rosebud County than for Forsyth; this, however, is a national trend.

One of the primary problems plaguing the Sheriff's Department is that salaries are set by law and are so low that the county cannot compete with local construction and mining jobs for workers. Force turnover is high, as deputies find it difficult to live comfortably on a law enforcement salary. Another difficult situation is the jurisdictional problem between the county and the Northern Cheyenne Indian Reservation.

The county jail is inadequate, but a new facility is under construction and is expected to be completed in the fall of 1978. The present jail capacity will be doubled to 24 and should be adequate for any current or future anticipated demand (table II-20, Coal impact expenditures).

8. Fire Protection

Large parts of Rosebud County have an insurance rating of Class 10, which means that they are "unprotected" against fire. Forsyth, a class 5 area, is served by a 16-man volunteer company; Colstrip has an 18-man volunteer department but only a Class 7 rating (as a result of low water supply and pressure problems). Due to inadequate equipment, Lame Deer, on the Northern Cheyenne Indian Reservation, has a Class 9 fire rating despite its large (26-man) force. In rural parts of Rosebud County, fire protection is provided by residents, supplemented by the county and by informal community cooperation (table II-22).

TABLE II-22.--Fire fighting capacity in Rosebud County

[NOTE: Patrol cars are equipped with small backpack tanker-pumper units]

Town	Equipment	Capacity
Forsyth------	Tanker-pumper truck	1,000 gal
	Tanker-pumper truck	750 gal
Colstrip-----	1959 International	1,000 gal
	1938 Chevrolet Pumper	500 gal
Western Energy Co.-	3/4 ton pickup tanker-pumper water wagon	6,000 gal
	Water wagon	8,000 gal
Lame Deer----	Old truck	250 gal
	Old tanker-pumper	1,500 gal
Rural--------	Army surplus truck	1,200 gal/min
	Army surplus truck	50 gal/min
	3 low-pressure spray trucks	250 gal each

9. Health

a. Facilities and programs

Forsyth has a well-equipped modern 18-bed hospital, which has the potential for providing a full array of medical services. Completed in 1973, the hospital serves both Rosebud and Treasure Counties.

A medical clinic is located in the Colstrip Community Center, and there is a first-aid trailer at the Rosebud mine. Due to staffing problems, emergency patients are usually transferred to Billings or Miles City. The Indian Health Service operates an out-patient clinic in Lame Deer. Lame Deer residents in need of hospitalization are usually transferred to Crow Agency.

Forsyth also has an ambulance service, a 47-bed nursing home, and the Eastern Montana Regional Mental Health District provides psychiatric consulting assistance and diagnostic services. Since 1974 the county has also had an alcohol- and drug-abuse program; the Northern Cheyenne Reservation program provides similar services.

Other social services are provided by the Rosebud County Welfare Department, AEM (Action for Eastern Montana) and by the TYRAC (Tongue River-Yellowstone Action Council).

b. Staffing

Staffing is the primary problem for the hospital at Forsyth; with only two physicians, the facility is underutilized. Consequently, many patients go to Miles City or Billings. Other hospital staff include 2 full-time registered nurses, 10 part-time registered nurses, and 7 full-time licensed practical nurses, who divide their time between the nursing home and the hospital.

There are three consulting physicians, a pathologist, a radiologist, and a physical therapist from outside Rosebud County who provide assistance on a routine basis.

The Colstrip facility is administered by the Miles City Clinic but it is in need of a doctor.

The Lame Deer Clinic has a staff of two physicians, three nurses, and an assistant and is adequate to handle the current demand for outpatient services.

County health services are provided for by a health officer, a public health nurse, a sanitarian, and a secretary. Mental health services are provided by a full-time clinicial psychologist in Forsyth.

A psychiatric nurse works at the Indian Health Service Clinic in Lame Deer, but a number of trained Indian counselors are needed. A clinical psychologist and social worker are located in Ashland to serve the southern part of Rosebud County.

The Eastern Montana Regional Mental Health District is in the process of recruiting a similarly qualified professional for Colstrip. The mental health services for the county appear to be sufficient for current and projected population levels.

K. LAND USE

1. Present Land Use

The approximately one-fifth (569 acres) of the 2,600 acres of Peabody mine property under study are dominated by the mine and its facilities (fig. I-9). Table II-23 provides a company estimate of the acreage of existing land uses within the developed mine area. The remainder of the land in the study area (about 2,000 acres) is used for livestock grazing.

An estimated 650 (AUM's) animal unit months of forage are produced annually on the 2,600 acre area. Within the smaller permit application area (1,264 acres), forage production is approximately 315 AUM's per year. (See appendixes K-1 and K-2 for range condition, biomass production, and recommended stocking rates.)

No public roads cross the mine property, and existing utilities serve the mine itself.

There are no occupied residences within the mine boundary; however, a small mobile home court is located in sec. 24 immediately adjacent to the mine boundary.

Agricultural land uses predominate in Rosebud County, grazing being the most extensive single use. Irrigated cropland is important along the Yellowstone River and, to a limited degree, along the smaller tributary streams. Urban land use constitutes only a few square miles, the largest acreage being in the communities of Forsyth, Colstrip, Lame Deer, and Ashland.

TABLE II-23.--Present land use within the existing operation at Big Sky

	Acres
Active mine pit plus the last two spoil ridges	75
Spoil revegetation areas[1]	325
Topsoil storage areas	20
Diversion ditches and siltation ponds	15
Access road	37
Haul roads with ditches	15
Electrical utility corridors	10
Railroad (From Cow Creek yards up to and including Big Sky loop track)	72
Subtotal	569
Grazing land	510
(This measurement was limited to the area from the McKay crop line to the Rosebud 100-foot recovery line in Peabody Area A)	
Total area of existing mine and facilities	1,079

[1]No mine spoil has yet completed the reclamation process to the point of bond release.

2. Federal Planning

The administration of federally owned minerals, including mineral fuels, is the responsibility of the Bureau of Land Management within the Department of the Interior. In the Big Sky mine area, BLM administers only a small amount of land surface, but the Federal Government owns the coal underlying about half of the land in the vicinity. Much of this Federal coal, therefore, is overlain by land in private ownership (figs. I-3 and I-4). The BLM is required to develop land use plans for those lands and resources under its care. Such an (Management Framework Plan) has been developed for the South Rosebud Planning Unit, within which the Big Sky mine would be developed. The mining permit application under study here is compatible with the MFP recommendations for the South Rosebud Planning Unit.

3. Local Land Use Planning

Since 1974 Montana has required regulation of subdivisions, not the number of lots subdivided, by counties, but a study by the Department of Community Affairs found that 93 percent of the land subdivided in seven counties escaped all review (DCA, January 1977). Local governments are permitted to plan and zone within their jurisdictions but are not required to do so. There is little desire to plan in the rural areas, even though the county recognizes the need for planning and regulation in high growth areas.

The Rosebud County Planning Board, which includes Forsyth, was organized in 1974. To date, the county has not produced a comprehensive or master plan. Instead, individual problems have been addressed by special purpose studies and/or proposed regulations. For example, the Planning Coordinator developed proposed commercial development regulations in an attempt to manage scattered or strip commercial developments. The county, however, has not adopted these regulations.

One of the problems in the county is that Colstrip is not incorporated and therefore lacks municipal powers. This has placed an added burden on the county government in some respects. Colstrip has been planned however: Montana Power engaged a consulting firm to do the design work for expansion of the original townsite. A new phase of expansion is currently going through the approval process.

L. TRANSPORTATION SYSTEMS

A gravel access road, 2.3 miles long, connects the Big Sky mine to State Route 315. Route 315 is a two-lane all-weather highway connecting Lame Deer and Colstrip with Interstate 94, just west of Forsyth. Route 315 intersects the east-west Federal Route 212 at Lame Deer. Traffic counts were made at two stations north and one station south of the Big Sky mine for the years 1967-76. Traffic increase over the period has been large. A tenfold increase occurred between Colstrip and Forsyth. Between Colstrip and the Big Sky mine, traffice increased more than fivefold, and between Big Sky and Lame Deer, just over threefold.

Recently, the heaviest traffic flows have been north to the Yellowstone Valley and the interstate highway. In 1976 the northern station recorded 2.8 times more traffic than the southern station. Unfortunately, Route 315 was not designed for the amount and type of use it is receiving. The speed limit is frequently violated and the number of vehicle accidents has risen. Plans have been made for the reconstruction of the more dangerous stretches.

A rail spur, 7.5 miles in length, connects the mine with the Burlington Northern tracks near Colstrip. Thirty-three miles to the north, at Nichols on the Yellowstone River, these tracks join the eastwest mainline. The track intersects the highway in a number of places and vehicle-train accidents have occurred at intersections without grade separations.

Coal production at Peabody in 1976 was approximately 2.3 million tons, exported by rail eastward to Cohasset, Minnesota, with an average of four unit-train loadings per week (100 cars of 100 tons each). These trains frequently impede road-vehicle access between areas for extended periods (in excess of 5 minutes).

There is no commercial passenger service on Route 315. Daily bus service and Amtrack rail service (on a seasonally varied schedule) are available for east-west travel from Forsyth.

Regular commercial air service is available at Billings or Miles City, Montana, and Sheridan, Wyoming.

The transportation system serving southeast Montana is described in chapter II of the forthcoming regional EIS.

M. RECREATION

There are no developed recreational facilities located in the permit area. It is conceivable, however, that some hunting, sightseeing, hiking, and other dispersed forms of recreation could be undertaken, but no use data are available to substantiate this. Because the land is all privately owned, the opportunities for general public use are limited on the proposed minesite. However, recreational facilities are found in communities within the county.

1. Urban Recreation

Developed facilities exist near the proposed mine area in Colstrip. Both indoor and outdoor facilities are used enthusiastically by the local residents. Outdoor facilities include: a 51-acre park system, a swimming pool and wading pool, three tennis courts, three basketball couts, and five tot-lots with play equipment. Indoor facilities are located in a 16,000-square-foot community center that includes basketball, handball, and racquetball courts, a meeting room, exercise room, and dining facilities (Colstrip Fact Sheet, August 1977).

The town of Forsyth also contains a variety of recreational opportunities. Local and State parks are located in and around town. These parks provide playgrounds and opportunities for fishing, boating, camping, and picnicking. The Rosebud County Fairground is located east of town. A nine-hole golf course is located west of town and includes a clubhouse. Other facilities include an ice rink, football and baseball fields, outdoor and indoor basketball and volleyball courts, tennis courts, swimming and wading pools, and a bowling alley. The facilities are well used, and maintenance rather than new or additional facilties is the primary recreation need. Forsyth has a diverse recreational program administered by two directors who also participate in planning long-range recreational needs.

Ashland recreational facilities are somewhat more limited. The Tongue River and Custer National Forest provide areas for fishing, hiking, picnicking, and camping. The town has two tennis courts and a new outdoor swimming pool. A playground and gym are located at the school. The Labre Mission has football and basketball facilities, which are used by the townspeople. The facilities are well used and are generally adequate for present needs.

2. Outdoor Recreation

Outdoor recreation resources are fairly numerous and varied in the day-use area (within a 50-mile radius of the permit area). Major attractions include Custer Battlefield National Monument; the Custer National Forest (Ashland Division); portions of the Tongue, Bighorn, and Yellowstone Rivers; and a number of historical sites.

A wide variety of use-opportunities are available. Developed facilities throughout the area include a total of 28 camping units, 25 picnicking units, 1 swimming area, 1 boat ramp, and 4 fishing access sites. Some of the most valuable opportunities include hunting (deer, antelope, upland birds, and waterfowl), warmwater fishing, river floating, moss-agate collecting (local semiprecious stone), and historical site-seeing. No specific data are available for determining actual use of the recreation resources in this area.

The Surge Pond Recreation Area near Colstrip totals approximately 6 acres and is accessible from State 315. A 1,200-foot service access road terminates at a 20-car parking area. Twelve picnic sites in a grove of ponderosa pine, a sand beach area, gravel paths, and a scenic overlook on a bluff above the lake, have been provided. Open areas for field sports are available, and access for nonmotorized boating and fishing is also provided. The surge pond has been stocked by the Department of State Fish and Game and will continue to provide for fishing opportunities in coming years.

N. CULTURAL RESOURCES

Cultural resources are fragile and nonrenewable remains of human activity, occupation, and endeavor.

Until the recent interest in mineral development, few cultural resource investigations had been conducted in southeastern Montana. The area of the proposed Big Sky mine expansion was surveyed by Fredlund (1973) and Anthro Research, Inc. (1977). A general summary of the identified cultural resource sites and their types is presented in table II-24.

TABLE II-24.--Summary of identified cultural resource sites in the area of the proposed Big Sky mine

Site type	Fredlund (1973)	Anthro Research, Inc. (1977)
Occupation site---------	3	6
Petroglyph site---------	6	2
Rockshelter-------------	2	2
Bison trap--------------	1	---
Quarry site-------------	1	1
Lookout site------------	5	4
Rock cairn--------------	---	1

Thirty-four archeological sites have been identified within the proposed permit area and vicinity (table II-24). Of these, 10 are within the area to be mined. One petroglyph and two lookouts in sec. 14 were determined to be common sites identified by both surveys. A review of these data have shown that additional survey must be completed to adequately cover the area of the proposed mine extension. An additional survey and evaluation is currently being undertaken which will fully cover the permit area and assure compliance with the Historic Preservation Act (Mitigating Measures (Stipulations), chapter I), and the procedures of the Advisory Council on Historic Preservation.

No sites currently listed on the National Register of Historic Places or the Montana Historic Sites Compendium are in the area of the proposed mine (appendix N).

O. ESTHETICS

The Big Sky mine area has above average scenic quality, Class B-11 (appendix O-1), based on the Bureau of Land Management Visual Resource Management system. This system attempts to quantify esthetic resources. Based on this and other input (appendix O-2) from the system, the mine site is located in a Visual Resource Management (VRM) Class II area. It should be noted that the VRM Class II rating is a direct result of the existing mining activities at the Big Sky mine and in the urban area of Colstrip. These activities have resulted in increased traffic, which raised the sensitivity level. Without this traffic fewer people would see the area; hence, the sensitivity level would be lower, and the VRM class would probably be III.

Esthetics are measured by the following elements: sight, sound, smell, touch and taste, of which sight is the strongest. Contrast of visual features, as evaluated by the use of line, form, color and texture is the best measure of impact on sight.

The Peabody Big Sky mine area permit application varies from gently rolling valley bottoms to steep, rocky canyon walls and small buttes. There is a moderate variety of colors ranging from scattered patches of dark-green pine trees, with varying shades of green grasses and shrubs, to light-tan sandstone outcrops. Flowing water is present on the permit area on a seasonal basis. Some small settling ponds are present in conjunction with the existing mining operation.

The vegetation in the area produces variations in patterns and texture, with pine trees and shrubs the dominate types. While the site itself is unusual, it is similar to other scenes throughout the region. While the adjacent mining operation somewhat diminishes the overall scenic quality of the area, it is not so extensive as to entirely negate the scenic qualities.

Due to the existing mine operations, industrial noises and odors dominate. Other noises and odors include those from animals, vegetation, and wind.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE COMPANY PROPOSAL

THIS CHAPTER ANALYZES IMPACTS OF PEABODY COAL COMPANY'S PROPOSED MINE AND RECLAMATION PLAN ON THOSE RESOURCES DESCRIBED IN THE PRECEDING CHAPTER. IN THIS MANNER, MITIGATING MEASURES AND UNAVOIDABLE IMPACTS CAN BE DETERMINED.

CHAPTER III

PROBABLE IMPACT OF THE PROPOSED ACTION

This chapter identifies impacts on the environment that would be caused by the mining and reclamation plan described in chapter I. The effects of the mitigating measures discussed in chapter I are taken into account in assessing the impacts. This chapter does not analyze the impacts of mining coal. It does analyze the impacts of the proposed mining and reclamation plan.

Administrative and technical alternatives to the mining and reclamation plan are evaluated in chapter VIII. These alternatives, if stipulated as part of the permit, could alleviate the adverse impacts described in this chapter.

This chapter emphasizes the adverse impacts that would significantly affect the quality of the human environment. Impacts which are by themselves less significant are also discussed because they may interact with and add to other adverse impacts.

Peabody's reclamation success at the Big Sky mine, to date, has been marginal. The Montana Department of State Lands has, on two occasions, required the company to submit investigative reports to the Department because of failure of seedling establishment on reclaimed acreages. This is particularly a problem on reduced highwalls. Additionally, those sites that become established tend to be dominated by alfalfa and yellow sweetclover. Both of these species, used at concentrations proposed by Peabody, tend to inhibit grass establishment. Data are insufficient to determine whether this is a long-term or a short-term problem. An undrained depression also exists on part of the existing reclamation. It is revegetating poorly and has, on occasion, trapped stray cattle from the adjacent ranching operation. Although violations have occurred at Big Sky, Peabody Coal Company is attempting to remedy the situation.

A. GEOLOGY

Implementation of the proposed mine expansion and reclamation plan would increase both erosion and sediment deposition on the permit area. Because the depressions would restrict the use of the entire area for grazing, future land use would be severely limited. (See Soils, chapter III.) Rates of hillslope erosion would increase because of decreased infiltration, loss of soil structure, and excessive slope lengths in mined and reclaimed areas. This, in turn, would produce excessive amounts of sediment, which would accumulate in undrained depressions currently planned by the company as a part of the reclamation

topography.[1] In depressions there would be an accumulation of sediment, possibly becoming saline in nature. As a consequence of this sediment accumulation and the temporary ponding of water in these depressions, there would be a decrease in vegetative diversity, species productivity, forage quality, and canopy cover. Additionally, the temporary ponds in these depressions would create deep mud holes dangerous to livestock. (See Soils, Vegetation, Land Use: chapter III.) Moreover, redevelopment of drainage would likely begin with gully formation, also limiting land use. These impacts could be mitigated if the company were to develop an alternate reclamation plan. (See chapter VIII and appendix P.)

1. Topography and Geomorphology

The mining operation would alter about 894 acres of hillslope and valley topography beneath the cliff at the minesite. The land surface would be lowered about 20 feet, and all drainage channels crossing the leasehold would be destroyed.

Although some mining currently occurs near Emile Coulee, most of the watershed is undisturbed. The following discussion considers the undisturbed portion of Emile Coulee.

Diversion channels routing stream runoff around the minesite would be designed to withstand the 10-year, 24-hour storm. There is a 52-percent chance that this storm would be equalled or exceeded during the 7-year mine life. More importantly, there is a 25-percent chance that a storm as large (or larger) than the 25-year storm would occur during the mine life. In the event of the 25-year storm, diversion channels could overflow. In places, these drainage channels traverse hillslopes, and if overflow occurs gullying would develop at the breakout point, and sediment would be deposited downslope. The mine pit could be flooded.

Locally, oversteepened hillslopes adjacent to proposed stream diversions would cause accelerated hillslope erosion. This excess sediment would be collected in settling ponds before the runoff would be released downstream.

Peabody is permitted by the Montana Department of Health and Environmental Sciences to release water containing a total suspended sediment concentration of 30 mg/L or 30 ppm. Wilson (1972) reported that runoff sediment concentration from summer thunderstorms in the Western United States exceeds 10,000 ppm. Water released from settling ponds would be sediment-deficient compared to natural stormflow and would disrupt the natural equilibrium of ephemeral channels below the mine. These channels

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[1] Such depressions must be approved under the OSM (30 CFR 715.14) and State performance standards as being compatible with postmining land use.

would incise into their alluvial floors to regain a sufficient sediment load. Stream incision might locally oversteepen channels and initiate scouring of the streambed down stream. Oversteepened channels could develop gullies off the minesite which would later spread upstream onto the reclamation surface.

The impact of reduced sediment load depends upon the amount of water passed through the settling ponds. Water quantity would depend upon the settling ponds' longevity, the number and magnitude of runoff events, and the amount of mine-pit water added to the streamflow. These ponds would provide a temporary surface water source after mining, but would also contribute to future gullying, as discussed above. The impact would be minimized if all settling ponds were removed as a part of final reclamation.

After mining, the minesite would be reclaimed to a new topography, according to State guidelines, which require that slopes not exceed 5:1, and would be nonerosive. However, it has not been demonstrated that 20-percent slopes would remain stable for the proposed slope lengths.[2]

In places, where coarse-textured soils would be placed over fine-textured compacted spoils, piping, a cause of gullying, could result. In addition, the reclamation surface would generally have higher erosion rates than the original surface because of the increased runoff resulting from decreased infiltration rates (Arnold and Dollhopf, 1977) and because of the breakdown of soil structure (Twidale, 1976). Sheet erosion, which occurs over the entire surface, is less dramatic than gully erosion but would likely produce more sediment than gully erosion. (See Soils, chapter III.)

A major source of geomorphic instability would be the incomplete integration of the reclaimed surface with the natural landscape. Many smaller tributaries to Emile Coulee would not be returned to the reclaimed surface. One tributary would be dammed near two trailer courts by the proposed reclaimed surface. Without maintenance, the pond behind the dam would fill with sediment and the dam probably would eventually breach under storm flow, causing stored sediment to erode and redeposit downstream. Gullying might be initiated and spread to the reclaimed surface.

Comparison of Emile Coulee longitudinal profiles (fig. III-1) of the reclaimed topography and the original surface show that the headwaters which formerly drained about 60 acres above the minesite would be dammed by the reclamation hillslopes labeled A-B. The settling pond formed behind this dam probably would fill with sediment, would breach, and then would gully. The gullying could spread upstream from the minesite. In addition, one segment of channel, labeled C-D, would be oversteepened in comparison to the previous profile. This could become a source of gullying. No information was provided concerning the reclaimed-Emile Coulee channel design; hence, stability cannot be evaluated.

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[2]State and Federal performance standards address only slope angle; however, erodibility is a function of both slope angle and slope length.

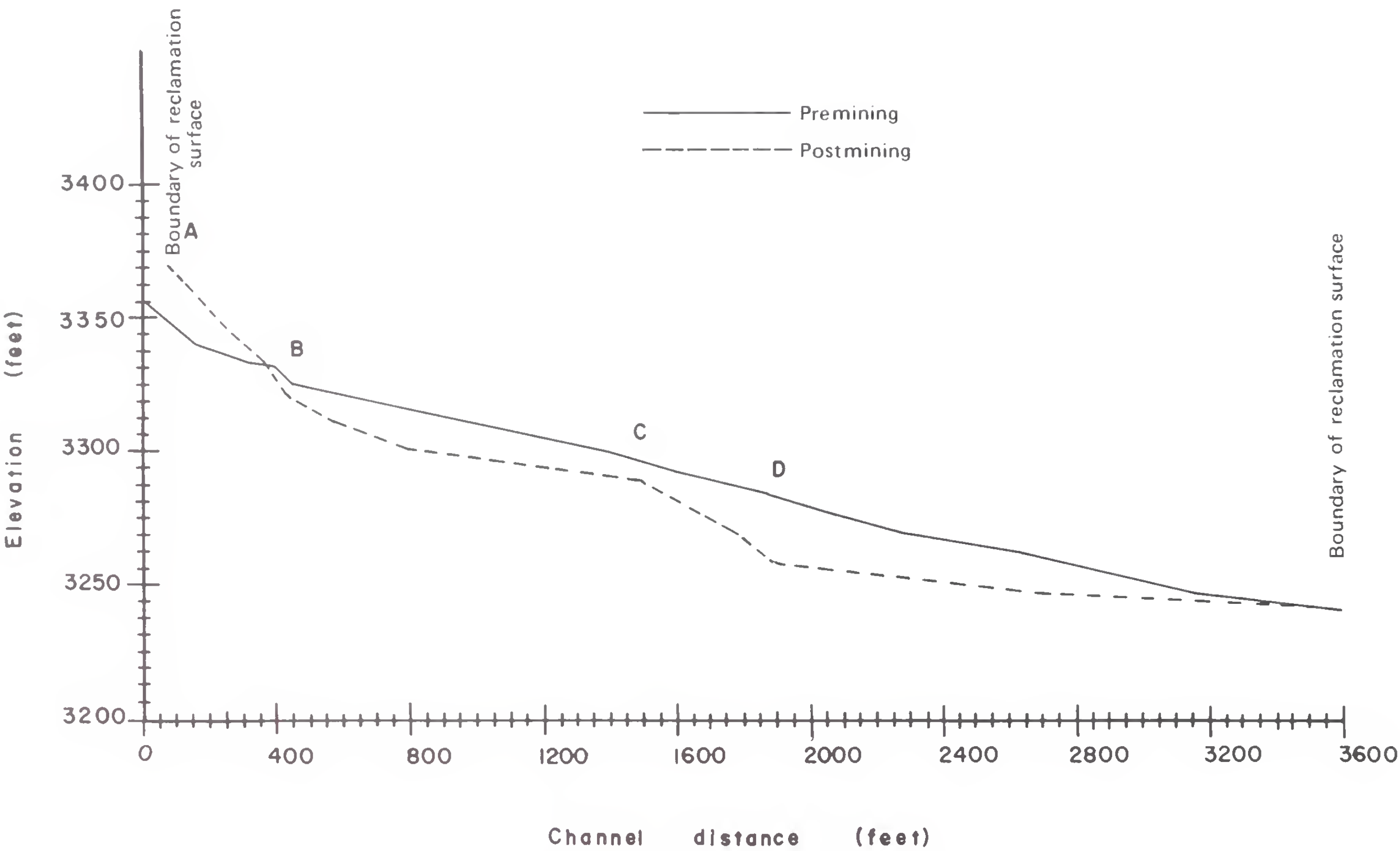

Figure III-1.—Longitudinal profile of Emile Coulee.

The failure to return a complete, well integrated drainage network to the reclaimed surface would result in a drainage network developing naturally. This would be a long-term process. During drainage development, reclaimed surface erosion rates would exceed natural erosion rates.

The reclaimed surface would contain numerous depressions which probably would not drain to the natural channel system. During periods of intense rainfall these low areas would collect surface flow. They would probably eventually seal with clay, causing decreased infiltration and increased water loss to evaporation. Dissolved salts would be deposited in the ponds and the sediments probably then would become saline. These depressions would probably not comply with State and Federal requirements.

As a result of disturbance, the overburden would undergo about a 22-percent increase in volume. During reclamation, some settling would occur from overburden weight and compaction by machinery, but settling would continue after reclamation. The subsidence rate would vary through the reclamation area, depending upon overburden thickness and the amount of water percolating through it. Planned depressions would probably expand and new depressions would be created, causing locally over-steepened hillslopes with increased erosion potential. Subsidence problems are not addressed in the reclamation plan.

The reclamation plan proposes that final highwalls would be reduced by backcutting to a 3:1 grade or less. Highwall erosion would depend upon the exposed rock type. Shale would weather rapidly and would form more gentle slopes; sandstone would erode similarly to the natural cliffs and would resemble the natural topography.

2. Overburden and Interburden

During the mining operation, the overburden and interburden stratigraphy, as it now exists, would be irretrievably lost. In itself, this would produce no significant impact: the local stratigraphy is not unique and has no intrinsic value. However, during the mining process aquifers included in the overburden would be destroyed, and the existing relationship among vegetation, soils, and bedrock would be disrupted, causing impacts to soils, vegetation, and ground water.

3. Coal

Between 2.3 and 4.2 million tons per year of coal would be mined.

4. Other Minerals

Clinker is the principal known nonenergy resource on the lease area. Resource depletion within the mine area would insignificantly impact the total resource within the Northern Powder River Basin. Other nonenergy mineral resources that may occur in the overburden are com-

mercial clay and sand and gravel. No plans were submitted to salvage these contingent resources; should they exist and be destroyed, the total impact would be insignificant.

5. Petroleum and Natural Gas

Mining would not interfere with Federal oil and gas lease M-29725.

6. Paleontology

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretative programs), and to other values. Losses would result from destruction, disturbance or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never occur except as a result of overburden clearance, exposure of rock strata, and mineral excavation.

All exposed fossiliferous formations within the region could also be affected by increased unauthorized fossil collecting and vandalism as a result of increased regional population. The extent of this impact cannot be presently assessed due to a general lack of specific data on such activities.

B. HYDROLOGY

1. Impact Summary

The main surface water impacts occurring as a result of mining would be increased sediment yield and increased runoff. Compliance with performance standards would require minimizing these impacts. However, the impacts would be primarily confined to the reclaimed surface and should not severely affect adjacent areas. Flow from a spring located in sec. 24 in Emile Coulee may decrease, limiting its future use as a source of stockwater.

The principal ground water impact would be the local destruction of the Rosebud overburden, Rosebud coal, and McKay coal aquifers. Groundwater recharge to the Emile Coulee alluvial aquifer may be decreased. The sub-McKay aquifer would remain intact, providing a source of well water. Locally, dissolved solids in the ground water would increase, possibly making the water unfit for domestic or stock use. These wells could be replaced, but operating costs for wells would increase.

Recharge to the sub-McKay aquifer might be slightly reduced, but impact to the adjacent subirrigated alfalfa field in sec. 24 is not expected to be significant.

2. Surface Water

As the land surface is disturbed by mining, it would be replaced with a reclaimed surface having a higher erodibility potential. (See Geology, chapter III.) Table III-1 gives the estimated annual sediment yield from the Big Sky mining operation.

TABLE III-1.--Big Sky estimated sediment yield[1]

[An estimated 168 acres would be disturbed each year and it is assumed that 168 acres would be reclaimed each year]

Year	1979	1980	1981	1982	1983	1984	1985
	Sediment yield (tons/year)						
1979--	1,150	460	460	460	460	460	460
1980--	1,150	1,150	460	460	460	460	460
1981--	1,150	1,150	1,150	460	460	460	460
1982--	570	1,150	1,150	1,150	460	460	460
1983--	460	570	1,150	1,150	1,150	460	460
1984--	460	460	570	1,150	1,150	1,150	460
1985--	460	460	460	570	1,150	1,150	1,150
1986--	460	460	460	460	570	1,150	1,150
1987--	460	460	460	460	460	570	1,150
1988--	460	460	460	460	460	460	570
Totals	6,780	6,780	6,780	6,780	6,780	6,780	6,780

Grand total----47,460 tons
37,800/1,750 = 27.12 acre-feet
Average for 10 years = 2.7 acre-feet per year

[1]The estimated annual sediment yield was computed using a factor of 2.5 acre-ft/mi^2/yr for area to be disturbed by mining, 1.25 acre-ft/ mi^2/yr for early stages of reclamation, and 1.0 acre-ft/mi^2/yr for effective reclamation. This table is based on the assumption that 168 acres would be disturbed at any given time. It is assumed that there would be no effective reclamation for 3 years, then that reclamation measures would be 50-percent effective the fourth year, and that reclamation would reduce erosion to natural amounts by the fifth year.

This estimate of sediment yield may be low. Studies by Lusby and Toy (1976) in Wyoming show that even successfully reclaimed lands have a higher erosion rate than undisturbed areas. Montana's experience in reclamation has been too short to provide data on erosion rates. If these estimates were doubled or tripled the sediment yield would be about 4-6 acre-feet/year. Excess sediment would collect in depressions on the reclaimed surface or would deposit along Emile Coulee. It would not reach the Rosebud except during rare storm events.

Decreases in infiltration would result in increased runoff of an unknown amount. (See Soils, chapter III.) Because the reclamation surface is improperly designed, much of this water would collect in undrained depressions where it would either be lost to infiltration or evaporation.

A pond in the northern part of sec. 24 would no longer receive water due to the interception of flow by a closed depression designed into the reclaimed surface.

3. Ground Water

As the mine reached the eastern part of sec. 14, it would intercept some of the recharge to the sub-McKay aquifer, the water from which a part of Snider's alfalfa field is subirrigated. Data are unavailable to determine if the decrease would be sufficient to adversely affect the alfalfa field. The principal adverse impact on the alfalfa field would result if there were a significant rise in the water table in the sub-irrigated part of the field; however, this would not be likely to occur.

The postmining impact to the ground-water supply for the alfalfa field is unknown. Assuming that the primary recharge to the sub-McKay aquifer occurs off the minesite, ground-water flow to the alfalfa field should return to premining conditions. Reduced infiltration to the reclaimed spoils would result in an unknown reduction in recharge to the sub-McKay aquifer. However, this should not have a significant adverse effect because this is probably a minor part of the total recharge area.

Secondary effects from the disturbance of the overburden and coal aquifers may occur in J. Snider's subirrigated alfalfa field because of an interruption to ground water flow in the mine area. The degree of disturbance of the ground water flow cannot, however, be quantified. About 5 percent of the field is underlain by the alluvium of Emile Coulee and the remainder of the field is on colluvium (slope wash). At this time, it has not been established how much of the remaining 95 percent of the alfalfa field is actually subirrigated and how much of the total moisture by the crop is from ground water.

Recharge to the alluvial aquifer should continue during mining. Mining would disrupt the upstream source of surface water to recharge the alluvial aquifer; however, much of this water would be diverted to sediment settling ponds on Emile Coulee, where the diversion water plus added pit water would be released downstream.

Postmining recharge to the alluvial aquifer may be affected. The expected decrease in infiltration would be more than offset by the failure of the reclaimed surface to drain. (See Geology, chapter III.) The net result would be decreased surface flow from the reclaimed surface. If the floor of the reclaimed Emile Coulee channel were permeable enough to permit rapid infiltration, this water would no longer be available to recharge the alluvial aquifer downstream, and ground-water availability in the alluvial aquifer would decrease. Alternatively, if the reclaimed channel floor were relatively impermeable, channel flow would cross the surface, recharging the undisturbed alluvial aquifer downstream.

Available data are inadequate to determine the effect of mining upon the flow of the spring on Emile Coulee. If spring flow is supplied by the alluvial aquifer, then a reduction is possible after mining. If spring flow is supplied by the sub-McKay aquifer to the south of the stream, mining should have little effect.

The Rosebud coal, the McKay coal, and the Rosebud overburden aquifers would be destroyed in the area to be mined. Wells that obtain water from these aquifers are all too remote from the mine to be significantly affected by the mine.

Recharge to the sub-McKay aquifer may decrease due to reduced infiltration through the reclaimed surface. However, since the recharge from this source is a relatively small part of the total, the net impact would probably be small. Two wells near the northern edge of sec. 24 obtain water from this aquifer and might be affected.

The quality of water from the mine spoils that would recharge the sub-McKay aquifer would deteriorate. This water would be a magnesium, calcium sulfate type similar to the present ground water but would be higher in dissolved solids. The median value for total dissolved solids in water from spoils at the Big Sky mine is 3,880 mg/L (Van Voast, 1977). Future use of ground water from the mine spoils for either livestock or domestic consumption may be precluded by such water quality degradation. The degree to which water quality in the underlying aquifer would be reduced is uncertain. However, the two wells in the northern part of section 24 may be adversely affected.

4. Water Use

It is estimated that water use for mine purposes would increase from 23 acre-feet to 42 acre-feet per year, most of which would come from the mine pit and be used for dust control. This is based on available data from the Decker mine. Additional water requirements are not expected to have any adverse impacts on long-term water uses.

C CLIMATE

The impacts of the proposed mine on the microclimate are estimated to be localized and quantitatively unknown. However, assuming reclamation is successful, slight changes in humidity, temperature, and wind patterns resulting from changes in topography and vegetation are anticipated.

D. AIR QUALITY

1. Introduction

The planned modifications of the Big Sky mine would contribute to the fugitive dust emissions in the Colstrip Nonattainment Area. The current mine plan has not outlined a dust mitigation program sufficient to offset the projected increase in particulate emissions. If Peabody Coal Co. were to implement those technical alternatives listed in table III-3, they could meet the "offset" requirements. The proximity of the mine to the southern border of the nonattainment area may also require that Peabody Coal Co. apply for a prevention of significant deterioration (PSD) permit.

Increasing the coal production at the Big Sky mine from 2.3 million tons per year to 4.2 million tons per year by 1981 would create additional adverse impacts to air quality. Fugitive dust emissions and gaseous emissions would approximately double. Under the current mine plan, fugitive dust emissions would total 5,445 tons per year by 1981 (table III-2, and appendixes D-3 and D-4), an amount 74 percent greater than could be achieved with best available dust control technology. This would mean a significant increase in the variability of the TSP 24-hour average and a general rise in the TSP annual geometric mean. The added increment of particulate emissions would also increase the violation frequency of State guidelines and Federal standards on the permit area and perhaps downwind of the mine. Violation frequency downwind of the site could be determined if new monitors were installed. Montana State guidelines are legally unenforceable, and those past instances in which applicable Federal standards have been exceeded have apparently not been cited as violations by the Montana Air Quality Bureau. Best management practices would be required by EPA. (See Mitigations, chapter I.)

These primary or direct impacts to the airshed would further effect changes, termed secondary impacts, in biological systems. Secondary impacts include (1) deposition of potentially toxic trace elements in overburden and coal dust onto the surrounding environment; (2) minor or undetectable changes in plant community productivity and composition; (3) potential trace element toxicity to honeybees; (4) detectable increases in respiratory diseases in domestic animals; (5) possible respiratory diseases in mine personnel; and (6) a decrease in the visibility characteristics and esthetics of the area. Impacts occurring

separately would not upset the ecosystem; however, over the long-term these impacts occurring together could significantly alter the biological stability and productivity of the area.

2. Fugitive Dust Emissions

Because the proposed increase in coal production would not be parallelled by tighter dust control on haul roads, at the coal handling facilities and unit train loadout, fugitive dust emissions would double. A 74 percent reduction in fugitive dust emissions could be realized if those mitigation techniques listed in table III-2 were implemented.

Unit trains travelling from the permit area would distribute between 4,200 and 17,640 tons of coal dust annually, (about 1,900 to 7,980 tons more than at present) along the 800-mile railway corridor between Big Sky and Cohasset, Minnesota (at 4.2×10^6 tons/yr with a 0.1 to 0.42 percent loss. Most of this loss would occur within the first 50 miles of transit (Paulson and others, 1976). Total suspended particulate concentrations could increase as much as 55 $\mu g/m^3$ over background levels within 30 yards of the source, with a train frequency of about 35 trains per day (NALCO Environmental Sciences, 1977). This increase includes dust stirred up off the tracks as well as coal dust off coal cars. A 87.5 percent reduction in coal dust emissions could be realized if a hot oil spray were used to treat coal (Nimerick and Laflin, 1977).

Indirect evidence shows that a particle size distribution similar to that which can be expected from the Big Sky mine is subject to considerable suspension and long-range dispersal (U.S. EPA, 1974; U.S. EPA, 1977). Quantities of particles which effectively scatter light (0.1 - 1.0 micrometers) may increase slightly, largely from haul road traffic and the coal handling facilities.

Diurnal fluctuations in wind direction suggest that throughout the driest months of the year fugitive dust may accumulate at the minesite during the day and disperse down the Miller Coulee, Emile Coulee, and Hay Coulee drainages in the evenings. Under these conditions impacts to visibility would be perceptible, expecially in the valleys, 2-3 miles downwind from the minesite. Fugitive dust from the Colstrip area combined with emissions from the Big Sky mine would often be carried in the same airflow pattern, east southeast of the nonattainment area. The lands which belongs to Jim Snider and Duke McRae (Greenleaf Land and Livestock Co.) will be most impacted by aerial dust fallout and decreased visibility.

The Northern Cheyenne Indian Reservation, a Class I airshed, is 12 miles south of the Big Sky mine. Although this airshed lies near the mine, changes in air quality due to the increased particulate emissions would not be quantifiable.

TABLE III-2.--Projected particulate emissions from the Big Sky mine after proposed dust mitigation and after best available dust control technology

Emission Source	Present actual particulate emissions (tons/year)	Projected actual particulate emissions[1] (tons/year)	Suggested BACT[2] (percent efficiency)	Hypothetical controlled dust emissions
Permit area				
Overburden excavation-------	557.1	841.7	Blasting mat, percent unknown	841.7
Coal extraction-------------	105.4	166.9	---	166.9
Coal hauling----------------	112.7	530.4	Water (50 percent) and chemical (88 percent)	128.9
Coal handling---------------	1,471.3	2,940.0	Completely enclose all crushing and conveying facilities (80 percent), install baghouse (99 percent), 99.8 percent	12.6
Wind erosion----------------	549.9	959.9	Install baghouse on coal storage barn (99 percent), 93.4 percent	252.3
Fuel combustion-------------	3.2	4.7	---	4.7
Employee transport----------	1.4	1.7	---	1.7
Permit area subtotal-------	2,801.0	5,445.3	74	1,408.8
Region				
Employee transport----------	3.2	0.1		0.1
Unit coal trains, coal dust-	2,300.0	4,200	Hot oil spray 1.5-2.0 gal/ton of coal, 87.5 percent	525
Locomotive fuel combustion--	10.1	18.4		18.4
Population effect, Forsyth--	6.5	24.5	---	24.5
Total regional sources-----	2,319.8	4,243.0	---	568

[1]Projected actual particulate emissions after the dust mitigation techniques proposed in the mine plan are implemented.

[2]Best available control technology (BACT).

Due to the increased population in and around Forsyth, particulate emissions would increase to approximately 24.5 tons annually by 1985 (table II-2). In the long term, particulate emissions could effect significant visual, esthetic, and health impacts to Forsyth.

3. Gaseous Emissions

Total gaseous emissions would increase by about 50 percent as a result of increased coal extraction at Big Sky mine. This amounts to a total of 696 tons annually of potentially harmful gases (appendix D-5). The majority of these emissions are not from the minesite but from regional sources, such as the unit coal trains (530.2 tons/yr) and population effect on Forsyth (169.7 tons/yr). Ambient concentrations of these gases are not expected to threaten human health and public welfare.

Acute nitrous oxide fumigations may occur after blasting episodes, impairing highway visibility and causing considerable discomfort to living organisms downwind of the blast. These would be most serious under daytime atmospheric-inversion conditions, not uncommon during the winter months.

4 . Biological Air Quality Impacts

a. Vegetation and wildlife

Secondary effects to vegetation, wildlife, domestic animals, and insects are discussed under Vegetation and Wildlife; chapter III.

b. Human effects

Dust generated by mining operations at the Big Sky mine could be expected to affect human health. Those workers at Big Sky exposed to high dust concentrations for prolonged periods of time may suffer some or all of the following diseases: coal miner's pneumoconiosis, silicosis, or industrial bronchitis, alone or in combination (Bergren, appendix D-6). These diseases are correlated to high silicon content of the coal dust and to extremely small particle size (Bergren, appendix D-6).

E. SOILS

The proposed mining and reclamation plan for the Big Sky expansion area contains features which make it unlikely that it would meet State and Federal criteria for successful reclamation. Therefore, the proposed mine and reclamation plan will have to be revised.

The major problem with the reclamation plan involves the proposed final surface topography, which is designed to include numerous depressions up to 10 acres in size. These depressions would occupy less than

5 percent of the area disturbed but would influence that entire reclamation surface. These depressions would become sealed by clay and silt and be partially filled with sediment and water. Such depressions have been previously formed on past reclamation which may have contributed to the death of a bull mired in the mud. Postmining land use for grazing would be severely restricted and, thus, would not meet State and Federal criteria for adequate reclamation. The capability classification (appendix E) of the entire area would be reduced to Group VIII, unsuited for grazing or crop production, due to the depressions acting as sediment traps which would also serve to trap cattle.

Closely related to the problem of sediment accumulation is the rate of sediment production, or erosion. The proposed topographic surface would be in a state of disequilibrium for reasons which are discussed in detail in Geology, chapter III. Critical to this state of disequilibrium is the amount of "topsoil" and other material which would have to be eroded, transported and redeposited on and off the site to ultimately produce a more geomorphically stable surface.

The increased rates of erosion would last an undetermined but long period of time. The rate of erosion would depend on the frequency and intensity of storms and the condition of vegetative cover at the time of intense precipitation. (See Climate, chapter II, p. II-15.) High erosion rates, especially sheet erosion, would retard the development of advanced plant communities and soil development. This, in turn, would encourage further erosion.

Productivity on the reclamation surface would be slightly decreased from potential levels over an extended period of time. Forage quality would be more severely affected, reducing the value of any postmining production. Quality would be lower because of the probable high weed composition and lack of species diversity for an extended period. Vegetative growth in the depressions, if allowed, would be minimal, affected by both frequent deposition of sediment and the accumulation of salts left by evaporating water.

In addition to impacts which are due to the mining and reclamation plan, there are impacts which would likely occur in any case. Physical and biological impacts to the soils would be more severe than those created by chemical changes. Neither type of impact is considered to be highly significant.

1. Physical and Biological Impacts

Water infiltration and permeability would decrease, resulting in greater run off and erosion rates, and decreased soil water storage for plant use and growth. This would be caused by a complete loss of structure and increased bulk density.[3] Bulk density of the surface soils

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[3]Lack of soil structure will lead to high bulk densities, over-grazed condition, notwithstanding. There will, of course, be localized exceptions.

would increase to a range of 1.55 to 1.75 grams/cm^3 from an already high 1.45 grams/cm^3 (Arnold and Dollhopf, 1977). Denser soils would increase resistance to root growth, encouraging shallow rooting and susceptibility to drought.

Water percolation within surface spoils would decrease by a factor of 1.5 to 3.5 (Arnold and Dollhopf, 1977). This has the potential of mitigating reduced infiltration rates to an unknown degree by retaining water in the rooting zone for plant use.

The population of soil micro-organisms would be decreased and distorted after initial bursts of growth. This would slow the decomposition of organic matter, retaining nutrients in an unavailable form which are necessary for further plant growth.

2. Chemical Impacts

The most pervasive chemical effect would be an increase in molybdenum uptake by plants, especially legumes, because the increased availability of this element in spoils. This uptake could cause copper deficiency disease (molybdenosis) in grazing animals (Erdman, et al., 1978). This problem may become insignificant by the time of bond release, because legumes may no longer be part of the plant community. The vegetation would be widely affected because molybdenum levels exceed State guidelines in all or part of every core-hole analysis submitted. Plant absorption of other metals probably would be low due to high soil pH. In the case of toxic heavy metals, this would be beneficial, although it would also inhibit the availability of some nutrients.

Sodium, which causes clays to disperse and inhibits soil development, would not be a major problem, but could cause localized difficulties if overburden with a high sodium-adsorption-ratio (core hole 2048) is not isolated and buried to avoid influencing the surface.

Overburden of high electrical conductivity is common in the permit area (Overburden, chapter II). Improper disposal of these materials could lead to saline "topsoil" conditions. Saline soils inhibit seed germination and plant growth.

Salvaged "A" horizon "topsoil" material would be oxidized and diluted, reducing soil organic matter by a factor of 2.5 or more. This would slow the process of soil structural development and reduce nutrient retention capacity.

Plant available nitrogen and phosphorus would decline. Although not proposed by the company, State regulations may require the use of fertilizers. The use of artificial fertilizers would compensate for deficiencies several fold. This, however, would have only a temporary effect because nutrients are not completely recycled, and phosphorus becomes unavailable in high pH soils.

Vegetation productivity could be very high during the initial 3-5 years of reclamation. This surge of growth would be caused by the release of nutrients following disturbance of the "topsoil" material. Nutrients are released by increased oxidation of soil organic matter, and increased exposure of soil particle surfaces. When these released nutrients are depleted from the soil, growth rates decrease dramatically. As nutrient cycling becomes reestablished, there may be some increase in productivity. Nutrients in plant materials are returned slowly, due to low decomposition rates, caused in part by the dry uniform microclimate at the soil surface. The use of fertilizer at this time would only serve to set back succession, encouraging weeds at the expense of slower growing native range species.

Following this period, productivity would most likely level off at a rate marginally to substantially below current potential[4] productivity. There is insufficient data available to determine the long-term productivity, following mining, in this region. At the present time, there are little data available to aid in making concrete predictions of this kind. Much depends on the skills applied in selecting and handling salvaged "topsoil" materials, planning and forming the postmining topography and drainage net, seed selection and seeding, as well as the amount and distribution of precipitation (or irrigation, if permitted, for initial establishment and survival).

If the problem of long-term accelerated erosion rates and sediment accumulation is corrected, "topsoil" spoils could be expected to develop a very weak platy or granular structure to a depth of 2.5-5 inches within the life of the mine. The top 2 inches may show slight decreases in pH and soluble salt content during this period. With successful vegetative establishment, infiltration rates could increase, possibly to the level of existing native range.

Long-term impacts, those which extend into the postbond release period, are difficult to project. Soil development rates are very slow in the region (Burkeland, 1974; Buol, and others, 1973; Curry, 1975). In 10 years, which is the earliest the bond can be released, it is unlikely that the reclamation surface would be sufficiently developed and stabilized to be reintegrated into normal land use patterns of the area. This would probably have no bearing on the legal definition of successful reclamation, but it would affect any subsequent use of the land. Overgrazing, heavy recreational use, or other mismanagement after bond release would lead to accelerated erosion and gullying. Once initiated, such processes are difficult to correct and could easily result in the area becoming barren and unproductive.

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[4]As measured by an exclosure at Colstrip on the Yamac soils series, which also occurs at Peabody (1600 kg/hm^2). (Frank Munshower, oral communication, 1978).

Under careful and informed management, light or moderate grazing would be possible in reclaimed areas. Light grazing would be beneficial by promoting incorporation of organic matter into the soil surface, thereby increasing rates of nutrient release and subsequent plant growth.

F. VEGETATION

The most serious impact on vegetation would be the long-term elimination of the natural vegetation mosaic and species diversity. This would seriously reduce the capability to provide suitable wildlife habitat and would change esthetic values, possibly for several decades.

Alterations to edaphic, topographic, geologic, hydrologic, and microclimatic conditions would inhibit successful revegetation. Even though reclamation must comply with State and Federal regulations, compliance alone does not insure success.

Because of both the length and steepness of reduced highwalls, as planned, sheet erosion would occur which would hinder the establishment of vegetation. Success of the revegetated community would be dependent on the vigor of the community at the time of major storms, and on the frequency with which these storms occur.

Plant establishment in those depressions planned by the company would be difficult, and only those species tolerant of environmental conditions could become established. Weeds would probably dominate. Species diversity would probably be low and the quantity and quality of livestock and wildlife forage would decrease as a result. If the surface topography were redesigned by Peabody Coal Co., these problems would be reduced. (See Soils, Geology, chapters III, VIII.)

For the first several years after reseeding, reclaimed areas would have a relatively uniform composition of grasses, forbs, legumes, and weedy species. Of those species becoming established, weeds or alfalfa and yellow sweetclover would dominate, inhibiting recovery of a "native" community. Seed present in the topsoil at the time of its removal would contribute only slightly to the new vegetation since the viability of most of the seed would be lost during stockpiling and redistribution of topsoil. Invading weeds would be relatively dense the first few years, then decline as perennial species crowd them out. The long-term post-reclamation livestock carrying capacity is estimated to range from 50 percent less than to 50 percent greater than before mining. Because of its homogeneous nature, the reseeded vegetation would be more susceptible to droughts and may have to be reseeded. Erosion of redistributed topsoil, primarily along graded highwalls, would also necessitate occasional reseeding.

A decade or two after reseeding, heterogeneous vegetation patterns would probably begin to appear along the mine boundaries near adjacent undisturbed vegetation and in localized microsites within the reclaimed

area. A wave of plant succession would gradually continue across the reclaimed area, from the oldest sites to the newest.

Several plant species would be reestablished with difficulty, particularly those which require specialized microenvironments for their maintenance.

If Peabody is required to recreate those conditions required by ponderosa pine, and many deciduous trees and shrubs, these species should be lost only for the short term. The Montana Department of State Lands is requiring 30 to 50 inches of coarse spoil material be placed on those sites to be revegetated with ponderosa pine. Additionally, topsoil used on such a site must be salvaged from an area that supported pine prior to mining. This should support populations of both pine and skunkbush sumac.

The Department is also requiring the selective salvage and replacement of alluvial soils in order to more successfully reclaim the moist drainages that existed prior to mining. Consequently snowberry and chokecherry should be easily reestablished. Not enough data are available on the resaturation of selectively replaced alluvial soils to determine the success of reestablishing green ash and box elder.

Several riparian shrubs and deciduous trees, particularly those requiring a perched water table, may be lost for several decades until necessary moisture conditions are recreated, and natural encroachment of these species occur. Competition with established grasses and forbs would delay this encroachment for an unknown period of time.

Reclaimed vegetation and native vegetation close to the proposed mine and facility locations would be impacted to varying degrees by disturbances, such as dust, off-road vehicle travel, and fire. These impacts would be of short duration, however, and would essentially cease with abandonment of the mine.

Dust arising from mining and increased activities around the mine would impact vegetation to an unknown degree. Prevailing winds would deposit about 70 tons per year per square mile of mine particulate emissions, easterly onto the soils and vegetation of the Big Sky mine area. The clay-shale and coal components of dust coming from mining would contain higher concentrations of the trace elements (table II-2) than are found in the topsoil. Only in areas of extremely high dust deposition may the physical accumulation of dust on leaves or the absorption of trace elements directly into plant tissues significantly effect changes in plant metabolism and plant community structure.

The most threatened plants, lichens, mosses, and algae, which obtain water and nutrients by direct surface absorption, rather than through root systems, would be exposed directly to potentially toxic levels of trace elements and dust accumulation on their photosynthetic surfaces. This would decrease the distribution of sensitive species and would

cause the loss of their functional role as primary colonizers of exposed soils (Gilbert, 1976).

Due to the alkaline pH of the soils of the region, only molybdenum from the dust would be absorbed in potentially harmful quantities through the roots plants. Dust accumulation on plants can (1) decrease carbohydrate production (Eller, 1977), (2) reduce lateral growth (Brandt and Rhoades, 1973), (3) cause chlorotic and necrotic lesions on leaves (Brandt and Rhoades, 1973, Manning, 1971); and (4) cause a shift in dominant species of both forests (Brandt and Rhoades, 1972) and grasslands (Kovar, 1977). It has also been shown that "concerning long-term effects, the coal dust is relatively toxic, as it reduces photosynthesis whatever the conditions of light and can even cause the death of the plant" (Auclair, 1976).

The presence of coal dust on the soil surface may also alter the local microclimate, increasing the absorption of solar radiation, and changing the temperature regime of the soil, soil microbial activity, and soil nutrient cycling, thus affecting the vegetation. The soils adjacent to the railroad corridor and downwind of the loadout area are of specific concern in this respect. As microclimate and grass-to-forb ratios change (Kovar, 1977) in the area downwind of the Big Sky mine, the grazing potential and cattle productivity of the vicinity could be diminished by an unknown amount. Increased susceptibility to fungal infection due to dust deposition (Manning, 1971; Shonbeck, 1960) may also reduce the nutritional value of the grasses.

In addition to causing dust, increased off-road vehicle travel would create significant localized soil compaction. Bury, and others, (1976) report direct damage, such as crushing, uprooting, and a reduced effective growing period, causing failure in plants to bloom or reproduce. Eriksson (1975) noted an 8-percent reduction in grain yield on clayey soils with normal farm traffic, and significantly greater reduction with additional tractor use.

There are no known, threatened, endangered, or noxious plant species occurring on the proposed permit area. Noxious weeds occurring in the county, however, may be early invaders on the reclaimed surface. To date, only Russian knapweed has presented problems, and then only on very specific minesites. State law requires the control of noxious weeds.

G. WILDLIFE

Expansion of Peabody Coal Co.'s Big Sky mine in Area A will disturb 1,264 acres of wildlife habitat; 894 acres will be directly disrupted by mining. Wildlife habitat types that will be lost to mining are discussed in chapter II under Wildlife.

Mining will remove a small but undetermined amount of riparian habitat, primarily those segments of Miller and Emile coulees within the proposed mine area. Upland terrestrial habitats (table II-2) comprise

the bulk of the area to be disturbed by the Peabody mine expansion. Within the upland terrestrial habitat of the permit area are several shrub and tree vegetative cover types (sagebrush, 20 percent; shrubs, 13 percent; and ponderosa pine, 13 percent) that would be lost to mining. Thus far, reclamation efforts have not successfully established these habitat types on a self-regenerating and self-sustaining basis. Consequently, an adverse impact of the proposed action would be the permanent (or at least very long-term) loss of certain habitat types (shrubs and trees).

Secondary impacts would include loss of plants by dust contamination which would adversely affect animals dependent upon those plants for food and cover.

Long-term ingestion by cattle of dust particles containing arsenic, beryllium, fluorine, lead, and zinc may adversely affect bacteria responsible for cellulose digestion, as well as accumulating in bones and body tissues. Increased ingestion of molybdenum (either accumulated in or on the vegetation) could cause molybdenosis in cattle (Erdman and others, 1978). Similar effects would be expected to occur in foraging wildlife. Dust particles on vegetation may also wear down the teeth of foraging animals, although quantitative data are lacking.

The increased surface particulate on soil and vegetation may disturb respiratory functions in cattle due to inhalation, deposition, and retention of the particulate in the gas exchange regions (alveoli) of the lungs (Lillie, 1970). There are indications that fugitive dust from strip mines may have increased cattle susceptibility to shipping fever and respiratory infection (MDHES, Public Hearing, March 11, 1978).

Dr. Herb Smith, a veterinarian, verified that there is a "consistent increased susceptibility to respiratory infection following particulate matter insult" (MDHES, 1978).

Trace elements tend to accumulate in insect systems, especially at the higher trophic levels. Low concentrations may be toxic depending on insect size, species, mobility, and feeding or behavioral patterns. Honeybees may be the most susceptible of animals to fluorine, arsenic, lead, copper, zinc, phosphorous, mercury, cobalt, and cyanide. They, and other pollinators, may accumulate these elements from pollen, making them very susceptible targets, even when trace elements are found at very low levels in vegetation and soils (Bromenshenk, 1978). Deposition on the soil surfaces may also poison soil/inhabiting insects (Bromenshenk, 1978).

Doubling of railroad traffic and an increase in road traffic would increase the potential for vehicle/animal collisions and disturbance of wildlife adjacent to the tracks, to an unknown extent.

The proposed reclamation plan fails to fully mitigate adverse impacts on wildlife. Some successful establishment of a moderately diverse grass and forb cover has been achieved in this region. However,

successful establishment of shrubs and trees has been quite limited and has not been obtained with ponderosa pine. Consequently, species dependent upon ponderosa pine and shrub habitat types (mule deer, sharptailed grouse, etc.) will be largely precluded from reclamation areas until those types can be reestablished. Considering the duration of several stages in vegetative succession of western environments, complete reclamation of shrub and ponderosa pine habitats may be long term or impossible to achieve.

1. Mule Deer

Mule deer winter range physically lost to mining activities is expected to be small relative to the total wintering area of the Peabody vicinity. However, disturbance from mining activities will likely limit or preclude existing use from adjacent wintering areas, although the magnitude of disturbance effects is unknown. Physical loss of wintering habitat, disturbance, plus interruption local movement routes would potentially lower the carrying capacity of the Peabody area for mule deer. This loss will be somewhat mitigated in time as the mine is closed down after coal extraction. However, the lowering of potential mule deer population will be a permanent adverse impact of the proposed action because reclamation efforts will not replace the topography or vegetation which comprises existing mule deer range.

2. Antelope

The greatest impact on antelope would be the interruption of existing migration routes through the area. It is not known if mining would cause a permanent shift from the preferred movement routes or simply cause the antelope to shift their movements to less preferred routes for the life of the mine.

3. White-tailed Deer

The overall impact on the local white-tailed deer population would probably be negligible. Those deer displaced from Peabody would probably shift to the lower stretches of Miller and Emile Coulees and to Rosebud Creek east of the permit area.

4. Small Mammals

The overall biomass of existing small mammal species would be reduced even after reclamation efforts are completed. Small mammal populations would be reduced by an unknown amount as a result of mining. Cottontail rabbits would be adversely affected because their escape cover (rock crevices and dense stands of shrubs) would be lost permanently (approximately 25 percent of the bonded area). Population of western deer mice and prairie voles would be significantly lowered because skunkbush/grassland and ponderosa pine, their habitat types, would be destroyed and would probably not be successfully reclaimed.

5. Raptors

Physical loss of nesting and hunting areas due to expanded mining disturbance would reduce the amount of habitat and prey available to raptors (fig. II-15) and consequently reduce local population numbers. Mining would preclude some raptor hunting because of the destruction of ponderosa pine. Some nests and future nesting potential for kestrels will be lost because these birds tend to select tree cavities as nest sites; and loss of trees to mining will be a long-term impact.

6. Upland Game Birds

Although no sharptailed grouse leks (mating areas) have been found in the permit application area, the direct and indirect loss of nesting and wintering habitat due to mining could alter sharptail population dynamics of the Peabody area. Breeding activity could be reduced at two known leks within one mile of the extended mine.

Additional mining activities would have only minor impacts to sage grouse because insignificant sage grouse use has been recorded and the area has been classified as marginal sage grouse habitat.

Mining would reduce the carrying capacity of most Hungarian partridge habitat in the Peabody area, because of the elimination of preferred habitats.

7. Songbirds

Adverse impacts of the proposed action would be a loss of songbird production and a pble change in species composition following reclamation efforts. Songbird nesting sites, critical for reproduction of the existing species, would be disrupted by disturbance from strip mining operations in the Peabody area. However, species with restricted habitat requirements (i.e. Brewers sparrow/big sagebrush, mountain bluebird/ponderosa pine) would be replaced by species more characteristic of grassland habitats (i.e. horned larks and meadowlarks).

As indicated by figure I-10, which shows proposed postmining topography, all rock outcrops (fig. II-15) except "number 1" would be removed during mining. Species using these outcrops are listed in appendix G-2.

8. Reptiles

Adverse impacts to the Peabody reptile population would be evidenced by loss of denning sites (sandstone breaks), and loss of the existing prey base.

H. SOCIOLOGY

If the proposed Big Sky mine expansion is permitted, it would produce additional growth, primarily in the Forsyth-Colstrip area. This growth

is not likely to have a noticeable affect on the existing social structure in spite of new demands placed on the communities. Some people would benefit from immediate economic gains; others however, most notably area ranchers, would feel their way of life further threatened. More newcomers would also increase the feeling of area ranchers that they are becoming still further disenfranchised from the local decision-making apparatus.

1. Population

The population of Rosebud County would increase by 163 between 1980 and 1985 if the proposed mine expansion were permitted (table III-3). The population of the Northern Cheyenne Reservation would not be expected to increase as a result of this expansion.

TABLE III-3.--Population projections, Rosebud County (1978-85)

Year	A Peabody @ 4.2 mty Western Energy A, B, & E-Colstrip generator plants 1 & 2	B Without Peabody expansion to 4.2 mty
1978-----------	9,585	9,585
1979-----------	9,623	9,623
1980-----------	9,900	9,809
1981-----------	10,142	10,030
1982-----------	10,412	10,249
1983-----------	10,581	10,418
1984-----------	10,766	10,603
1985-----------	11,009	10,846

Because most housing in Colstrip is reserved for Western Energy employees, most impacts of population growth due to the Big Sky expansion would occur in Forsyth. Little rural settlement is expected.

2. Social Structure

The proposed expansion of the Big Sky mine is of such modest porportions that it is not likely to have a noticeable impact upon the social structure of Rosebud County. However, if viewed as another step in a continuing series of coal development activities, approval of the Big Sky mine may further accentuate the value conflicts already evident between those who favor and those who oppose plans to mine the coal reserves of this area. Local farmers/ranchers who regard ranching as a way of life have most to lose if coal development activities accelerate in the future. From their point of view, industrialization and urbanization of the way of life is simply incompatible with their traditional agrarian lifestyles.

Gold (1974) reported, however, that even those residents who favor coal development (e.g., local businessmen), are opposed to rapid industrialization of the area because neither Forsyth or Colstrip, nor Rosebud County are prepared to accommodate continued growth in the population. If coal development were to continue at the same pace it has over the past few years, it is likely that residents of Forsyth and Colstrip would begin to feel the same sense of alienation that currently affects area farmers/ranchers.

I. ECONOMICS

Increased mining activity at the Big Sky mine would generate some additional impacts in Rosebud County, but most of these would be relatively minimal. Impacts would be reflected in employment, income, and public finance.

Projected economic impacts are based on the Coaltown II model (Temple, 1978). The impacts defined below are based only on the Big Sky mine expansion. In reality, concurrent development could be expected that would vastly alter the impacts projected below. Some alternative developments are presented in chapter VIII.

1. Employment

Base employment is projected to decline between 1978 and 1985, assuming that coal production from Western Energy Areas A, B, and E would cease if no further action(s) occurred (table III-4). As a result of the Big Sky extension, a projected increase in employment of 54 people, including ancillary workers hired elsewhere in the county, by 1985. A far greater number of people would be expected if the Rosebud mine expanded and/or if Colstrip Generating Units 3 and 4 were built.

TABLE III-4.--Employment projections, Rosebud County, 1978-85 with (a) and without (b) expansion of the Big Sky mine

Year	Base Employment		Ancillary Employment		Total Employment	
	(a)	(b)	(a)	(b)	(a)	(b)
1978----	2,171	2,171	2,345	2,345	4,516	4,516
1979----	2,101	2,101	2,419	2,419	4,520	4,520
1980----	2,119	2,101	2,529	2,521	4,648	4,622
1981----	2,129	2,101	2,637	2,624	4,766	4,725
1982----	2,132	2,100	2,745	2,728	4,877	4,828
1983----	2,126	2,094	2,849	2,830	4,975	4,924
1984----	2,061	2,029	2,927	2,906	4,988	4,935
1985----	1,968	1,936	2,989	2,967	4,957	4,903
Projected change in employment from 1978 to 1985:						
	- 204	- 235	+ 644	+ 622	+ 441	+ 387

2. Income

Per capita income in Rosebud County would increase as a result of the Big Sky expansion. In comparing the payroll differences due to the mine expansion, it is estimated that an additional one-half million dollars or more would be dispersed yearly.

3. Revenues and Expenditures

If Peabody were the only development between now and 1985, and if production from Western Energy Areas A, B, and E dropped off, as projected, State and County revenues would decline over time, as shown in table III-5. In the table, caution should be noted as to what negative and positive surpluses mean. Positive values indicate that in the future, Rosebud County would have the ability to meet the respective social services which would be needed. Negative values reveal that given the current mill levy rate in Rosebud County, the County would not be capable of providing adequate services required for the public. The estimated shortfalls in the county would occur only if millage rates and property taxes remained constant, an unlikely situation.[5] Intergovernmental transfers would also change the negative and positive values.

Although per capita revenue for Forsyth declines (table III-5) total revenue for the city increases, indicating a decrease in expenditures or an increase in population. That is, if the population increases faster than the tax base, the tax rates will have to increase if per capita expenditures are to remain the same. School district revenues (table III-5) would decline but no shortfalls would occur, with the exception of the Forsyth Elementary School District.

Another fundamental problem facing the county is that after 1980, severance tax monies going to the county will be reduced (appendix I-4).[6]

J. COMMUNITY SERVICES

The increment of impact that the Big Sky mine expansion would contribute to community services in Rosebud County is not expected to be significant relative to other sources of impact.

Any population increase, however, would further stress the existing law enforcement and fire protection capabilities of the county because of personnel turnover and outdated fire-equipment, respectively. This situation would remain until turnover is decreased and until equipment can be replaced. Health services would be similarly stressed because

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[5] These rates have to be fixed in the Coaltown II model.

[6] This is due to State law.

TABLE III-5.--Revenue projections, Rosebud County, 1978-85, with and without[1] expansion of the Big Sky mine

[1970 dollars]

Year	State revenue	Rosebud County			School districts			Per capita town revenue	Forsyth revenue
		Revenue	Expenditures	Surplus	Revenue	Expenditures	Surplus		
With Big Sky mine expansion									
1978--	$26,928,416	$1,124,782	$1,147,666	$ -22,884	$3,854,451	$2,240,470	$+1,613,981	$35.36	$169,610
1979--	28,978,224	1,187,919	1,149,651	+38,268	4,015,003	2,246,405	+1,768,598	35.53	171,423
1980--	36,145,216	990,948	1,165,365	-174,417	4,555,457	2,293,591	+2,261,866	35.44	178,520
1981--	33,660,944	945,875	1,183,861	-237,986	4,363,729	2,349,563	+2,014,166	35.28	186,589
1982--	33,699,488	946,618	1,201,922	-255,304	4,373,491	2,404,673	+1,968,818	35.13	194,549
1983--	29,487,200	842,273	1,219,040	-346,767	4,052,575	2,457,316	+1,595,259	35.01	202,174
1984--	30,935,520	898,545	1,227,643	-329,098	4,171,306	2,483,918	+1,687,388	35.01	202,177
1985--	20,922,000	721,844	1,231,723	-509,879	3,432,849	2,496,569	+936,280	35.08	208,827
Without Big Sky mine expansion									
1978--	26,928,416	1,124,782	1,147,666	-22,884	3,854,451	2,240,470	1,613,981	35.36	169,610
1979--	28,978,224	1,187,919	1,149,651	+38,268	4,015,003	2,246,405	1,768,598	35.53	171,423
1980--	34,466,672	961,224	1,162,570	-201,346	4,423,681	2,285,176	2,138,505	35.49	177,431
1981--	30,124,800	883,359	1,179,392	-296,033	4,087,067	2,336,000	1,751,067	35.35	184,828
1982--	30,158,048	884,209	1,196,602	-312,393	4,096,977	2,388,395	1,708,582	35.21	192,425
1983--	25,946,720	810,064	1,213,443	-403,379	3,776,825	2,440,059	1,336,766	35.09	199,910
1984--	27,395,040	836,501	1,221,730	-385,229	3,896,158	2,465,622	1,430,536	35.09	204,005
1985--	17,383,456	659,983	1,225,474	-565,491	3,338,647	2,477,199	861,448	35.17	206,263

[1] "Without" assumes no new industrial growth in Rosebud County.

they are understaffed at present. This will remain so until adequate staffing can be obtained for the facilities.

The impact to housing is dependent upon any concurrent development at Colstrip by the Western Energy and Montana Power Companies. Even without concurrent development, housing cost and rent would remain high and the apparent shortage of single-family homes would be heightened. However, construction of single-family units would increase. Although housing is not available, there are enough vacant lots in Forsyth to absorb any growth associated with this expansion (Meadowlark, 1978). Families on lower and fixed incomes would still be under considerable pressure as long as in-migration is occurring in Rosebud County. Due to the major role mobile homes play in fulfilling housing needs within the county, housing demand will increase as many mobile homes, as well as some of the older housing stock becomes structurally obsolete. If any concurrent development occurs in the next 10 years, this could be a major impact.

The impact on schools would be minor except at the Forsyth Elementary School, which lacks any extra money for special programs. If several families with school-age children choose to locate in Lame Deer, the school district would be in need of impact assistance. It could not cope with any additional students.

If growth occurred in Colstip, which is unlikely given the housing policies of WECO, the capacity of the water system would be exceeded, and the plans for expansion would have to be implemented immediately.

The impacts to all other community services in Rosebud County, due to this expansion, are expected to be negligible.

K. LAND USE IMPACTS

The major direct land use impact of the proposed mine expansion would be the addition of 894 acres (1.4 square miles) of mining disturbance to the already existing industrial complex. This is not a major land use change relative to the size of existing Big Sky and adjacent Western Energy Company operations. Secondary impacts would occur as some additional lands were converted to housing and commercial uses to serve new employees. Secondary impacts to future land use would occur from the inadequate reclamation proposed in the company's plan. (See Geology, Soils, Vegetation, chapter III.)

1. Local Impacts

Of the approximately 2,600 acres within the study area, an additional 894 acres are projected to be mined (table I-1). This would average about 112 acres per year over the life of the mine. Existing land uses would be disrupted during the mining phase. As proposed, the

reclamation plan incorporates a number of undrained depressions (Soils, Vegetation, chapter III) which would severely lower the value of the reclaimed surface for postmining uses. As a result, the reclaimed surface would be Class VIII land because of land forms which preclude its use (Soils, p. II-33; appendix E).

It is estimated that at any one time 168 acres would be disturbed at the mining level (table I-1), resulting in an annual reduction of 42 AUM's (animal unit months) of forage production. The disturbed land would be returned to grazing after mining ends and revegetation is successful. Wildlife habitat on reclaimed land would probably be restricted to grassland types. The restoration of woodland habitat, if attainable, would require many years. Details of impacts to wildlife, recreation, and watershed uses are discussed elsewhere in this chapter.

Table III-6 compares land use in 1977 and 1985, based on the company's application (chapter I).

Land containing the proposed mine area is currently under the control of Peabody Coal Co. through ownership or lease; approval of the permit would not alter this condition. Because of the already limited use of this area for grazing, the proposed mine expansion would have minimal impact upon the livestock economy.

TABLE III-6.--Estimated land use, comparing 1977 and 1985 (acres)

	Acres		
	1977	1985	Change
Active mining----------------	75	112	37
Spoil revegetation-----------	325	1,182	857
Associated disturbance-------	146.58	342	195.42
Facilities-------------------	12.42	27.57	15.15

No public roads or rights-of-way presently cross the mine area. Existing powerlines, which may require minor relocation, were constructed to serve the mine and should not affect other customers.

2. Regional Impacts

Land use changes in the surrounding region, resulting from the Peabody mine expansion, would be influenced by the expected increase in production through the years 1980 and 1981. Annual output from 1981 through 1985 would be 83 percent above the present level.

Thirty-two new mine employees would require housing, recreation space, and community services. This demand should primarily impact land use in the communities of Forsyth, Colstrip, and Lame Deer. These three

communities house 93 percent of the present mine workers. Forsyth alone accommodates 69 percent of Peabody's present workers; however, planned expansion of Colstrip residential and commercial area in response to the proposed construction of Electric Generating Units 3 and 4 may attract a greater share of the new Peabody personnel.

As population grows, there would also be a slight increase in pressure toward small scattered rural residences.

3. Cumulative Land Use Impacts

The proposed Peabody mine extension is only a part of the long-range development envisioned by the company. A total of 4,307 acres of Federal coal are under lease in areas "A," "B," and "C," identified in figure I-2. Area A, on Emile and Miller Coulees, would be completely developed by this proposal. Area B on Lee Coulee and Area C on Richard Coulee would be developed in future years. The total mineable area of units A, B, and C amounts to about 3,400 acres.

Also in the immediate Colstrip area, Western Energy Co. has received State permits for mining and related activities on a total of 5,628 acres of land, with further expansion proposed for the future.

Major land use changes associated with Colstrip area mines (Western Energy and Peabody) will be felt over a period of 20-40 years as each mine progresses through the cycle of development to exhaustion of the recoverable reserves.

Since rehabilitation measures would be implemented as mining progresses, the total number of acres disturbed during the life of these mines would constitute a rotation in land use, spaced over the life of the mine. The more permanent changes in land use would result from roads, railroads, powerlines, and the induced urban and residential development. Rural areas not subject to stringent land use controls and land development regulations may be adversely impacted by scattered development and thus affect adjacent land values.

4. Impacts on Planning

Although the expansion of Peabody Big Sky is relatively small, it will nonetheless add to already growing pressures upon county and municipal governments to expand their planning programs. The rapid growth and associated strains on all aspects of government and society conflict with traditional reluctance to plan. It should become increasingly apparent that planning can help eliminate or reduce impacts. This change would nevertheless be difficult for many present landowners to accept because it may reduce their independence of action with regard to use or disposal of land. Others may object to the financial and time costs involved in greater commitment to land use planning.

Efforts are seriously behind in data acquisition, policy formulation, and public education necessary for mitigation of impacts. This will require "catch-up" planning, and working under the handicap of existing growth patterns.

L. TRANSPORTATION SYSTEMS

Project impacts upon transportation would arise from an increased volume of traffic on existing systems. New mine employees would produce a modest increase in road and highway use. Train movements on the Peabody spur may double by 1981 but would still constitute only a small fraction of local system capacity. Grade-crossing delays would rise with train and vehicular traffic increases. Train/vehicle accidents would also increase proportionately unless mitigation measures such as grade separations are instituted.

1. Local Impacts

a. Highways

Traffic on local roads should increase in proportion to the expected rise in mine employment. Because this plan is an extension of an existing operation, only 163 people are expected to be added to the county population by 1985. Most modern families have one or more vehicles which will add to existing street and highway use, parking-space demand, and demand for vehicle repair and services.

Increasing mine output should increase traffic generated by delivery of supplies and equipment. After 1980 traffic increase on State Highway No. 315 as a result of the Big Sky mine may be noticeable. Traffic increases would be correlated with the rate of coal production, reaching a peak in 1981. This higher level would be sustained for 5 years.[7]

Committed and proposed reconstructions and improvements by the Highway Department should maintain Route 315 in good condition. The extent to which heavy truck traffic is generated by the mine and associated new residents would be more important to the future condition of the roads than the total volume of traffic generated.

The existing 2.3 miles of mine access road from State Highway No. 315 is adequate for present and projected traffic.

b. Railroads

Train movements on the Peabody rail spur would double from present

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[7] Current mine output is 2.3 million tons/year. Projection for 1980 is 3 million and in 1981 the sustained peak of 4.2 million TPY would be reached.

levels when peak mine production is reached in the period from 1981 through 1985. Beginning in 1981, 8 unit trains per week would be loaded (16 one-way passages).

No rail construction would be required by the proposed mine expansion. Service would continue over the 7.5 miles of spur line connecting to the Burlington Northern mainline at Colstrip.

2. Regional Impacts

At peak production, unit train movements would double the present number generated by the Big Sky mine (16 movements per week versus 8 at present). As a result, grade crossing delays and increased potential for accidents would be felt all along the route from mine to the coal destination. No specific statement can be made about the duration of these delays or the degree of hazard since these vary widely with each crossing situation. Train speed through crossings is influenced by a variety of factors including grade, track conditions, proximity to scheduled stops, or speed restrictions imposed by towns and cities on the route.[8]

Assuming that the rail crossing of Route 315, opposite the Big Sky mine, is similar to a crossing at the Decker mine, there would be an average of 5.5 minutes crossing delay for each trip. As a result of this project an additional eight trips per week would cause about 44 minutes of delay each week at the crossing opposite Big Sky and at each crossing in the town of Colstrip.

Between Colstrip and Nichols Junction on the Burlington Northern mainline track, the railroad crosses Route 315 at two additional places. These crossings are in open country and, at maximum speed, additional delays at each would be a minimum of 12 minutes per week.

If present residency patterns of Peabody employees are maintained, an additional 20 to 25 workers would be traveling Route 315 between the Big Sky mine and residences along the Yellowstone. Three or four more workers may commute to Lame Deer and the remainder would reside in Colstrip.

A minor increase in regional demand for air service from Billings or Miles City, and rail passenger and bus service from Forsyth may be expected due to this increased employment.

3. Cumulative Impacts

The increase in coal train movements from 8 to 16 (4 to 8 round trips) per week would be added to increases related to the Western Energy

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[8]See forthcoming regional EIS for more detailed discussion of grade crossing delays.

Company's Rosebud mine at Colstrip. When coal leaves the Big Sky mine, the current transport route is north to the Burlington Northern mainline at Nichols, on the Yellowstone River, and then eastward through North Dakota about 800 miles, to Cohassett, Minnesota. Increased Big Sky output would also add to impacts from existing and potential freight movements from the Absoloka mine on Sarpy Creek, and to coal movements circuitously routed from the Decker area or Northern Wyoming mines. Total product from Big Sky would represent about 15 percent of the total rail shipments along the Yellowstone River mainline by 1985.

Following, is a list of the kinds of impacts which may be felt system-wide by increase in coal traffic:

1. Periodic obstruction of at-grade road crossings and consequent delay of vehicular traffic, including emergency vehicles, school buses, mail-delivery vehicles, and general farm-to-market traffic.

2. Increased hazard of train/vehicle and train/livestock collisions where crossings are at-grade and are not adequately protected. Roads in rural areas are commonly used as livestock driveways enroute from one pasture to another.

3. Increased losses of livestock and wildlife in those areas where existing fences are substandard or where maintenance is inadequate.

4. Increased frequency of noise pollution.

5. Increased windblown and accidental spillages of coal.

6. Increased gaseous emissions and consequent air pollution along the railroad right-of-way and adjacent areas.

7. Increased hazard of railroad-caused fires.

8. Increased track and equipment maintenance costs.

9. Increased income to the railroad.

10. Increased employment by the railroad.

M. RECREATION

1. Outdoor

The fencing and excavation of the proposed mine would result in the loss of approximately 1,978 acres of potential recreation area for the life of the mine. This loss would be minimal. In recent years, increasing amounts of private land have been closed to the recreational public. This is partly a result of antagonism toward mining, of increased numbers

of recreationalists, and of existing or anticipated damage to the property. Additional recreational pressure may result in additional closure of private land.

Montana Department of Fish and Game (December, 1977) reports that there has been a tremendous increase in poaching and trespassing in the Colstrip area. This appears to result from the additional population attracted to the mining operations. It is assumed that this will continue to increase as additional employment becomes necessary for mining in this area.

2. Urban

Use of existing urban recreation facilities as a result of the new mine is not expected to increase to any significant extent, as this mine is an expansion of an ongoing operation. However, without increased attention to current problems associated with inadequate park maintenance and underdeveloped parks, the quality of recreational services would continue to deteriorate as the population increases.

N. CULTURAL RESOURCES

Impacts to cultural resources would consist of losses of archeological and historical sites for scientific research, public education, and other values to those sites adjacent to the permit area, not required to be mitigated. Losses would result from destruction, disturbance, or removal of cultural resources as a result of coal mining activities, unauthorized collecting, and vandalism.

Thirty-four known prehistoric sites and an undetermined number of unknown sites would be disturbed. In the area to be mined, ten sites would be destroyed, 24 sites in the peripheral areas may be destroyed or disturbed to an undetermined degree.

A beneficial impact of development would be the gain in knowledge derived as a result of the cultural resource investigations which otherwise might never occur except as a result of mining. Mining will not be permitted until the current survey is completed and the Advisory Council has reviewed the report.

O. ESTHETICS

The greatest impact on esthetic qualities would be the continued change in esthetic values for the life of the mine. Following reclamation there would be additional change as the site is returned to a more natural state. However, the site would never be returned to its premining condition.

The changes in landform resulting from overburden removal would create the strongest visual impact as the existing onsite landforms

would be destroyed. These impacts would be noticed on approximately 1,264 acres.

Topsoil stripping and facility construction would remove the existing vegetation, producing an "edge" effect creating contrast with the remaining vegetation and changing in the existing color scheme.

The major visual impact results from changes in the form and texture of land surface features. The rather abrupt transition from the mined area to the unmined area would create a sharp visual contrast. The present irregular land surface would be changed to a relatively smooth, sloping plane upon completion of reclamation.

No significant visual disturbance related to vegetation or structure features after successful reclamation would occur.

Throughout the reclamation sequence, esthetic qualities would begin to revert toward those of nature, and following reclamation, would once again be exposed to natural influences.

CHAPTER IV

MITIGATING MEASURES

THIS CHAPTER PRESENTS MEASURES THAT WOULD LESSEN OR ELIMINATE THE ADVERSE IMPACTS OF PEABODY COAL COMPANY'S PROPOSED MINE EXPANSION. THESE MEASURES ARE PRESENTED AND ANALYZED AS PROCEDURES THAT WOULD BE REQUIRED IF THE PROPOSAL IS APPROVED.

CHAPTER IV

MITIGATING MEASURES

Measures that would be employed to mitigate the adverse impacts of mining are (1) those measures proposed by the company as a part of the mining and reclamation plan (if the plan is approved, the measures are binding on the company); (2) those measures required to meet the standards required by various Federal and State laws and regulations, the principal agencies being outlined on page I-3; and (3) additional requirements or stipulations that could be imposed at the discretion of the Area Mining Supervisor, the Commissioner of the Montana Department of State Lands, or other Federal or State agencies which have permit authority (such requirements must be reasonable, noncapricious, and enforceable). The mitigating measures proposed by the company or required by various laws and regulations are discussed in chapter I of this statement (table IV-1).

Additional mitigations which could be imposed at the discretion of permit-issuing agencies would necessarily be based on need, as indicated by the failure or anticipated failure of proposed and required mitigations. Failure of mitigations could be identified through required monitoring and observation during mandatory inspections by the Area Mining Supervisor, USGS; staff personnel, Office of Surface Mining; the District Manager, BLM; Reclamation Division, Montana Department of State Lands; and other responsible State and Federal agencies.

Further measures and standards that could be imposed are discussed as alternatives in chapter VIII (table IV-1).

TABLE IV-1.--Mitigating measures

CHAPTER V

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

THIS CHAPTER PRESENTS THE ADVERSE IMPACTS OF PEABODY COAL COMPANY'S PROPOSAL THAT WOULD REMAIN AFTER APPLICATION OF THE MITIGATING MEASURES DISCUSSED IN THE PRECEDING CHAPTER.

CHAPTER V

ADVERSE IMPACTS THAT CANNOT BE AVOIDED IF THE PROPOSALS ARE IMPLEMENTED

The reclamation surface of 894 acres would be highly erosive. Erosion rates up to about 2.5 times above normal would return to normal only after long periods of time.

The localized destruction of the overburden aquifer and two coal aquifers could not be avoided. Water supplied from these sources could, however, be replaced by wells drawing from the sub-McKay aquifer. There would be a significant increase in dissolved solids in the water moving through the reclaimed spoils. It is not known if mining would affect the subirrigated portions of Snider's alfalfa field or if flow from the spring in Emile Coulee would decrease.

Air quality would be degraded during mining by increases in concentrations of fugitive dust (nearly double) and gaseous emissions (up to 5 percent) because of the increased mining activity. Since proposed dust mitigation measures do not represent the best available control technology, both State and Federal primary and secondary standards would be sporadically violated. Unavoidable secondary impacts would include: reduced visibility and esthetic value for several square miles around the mine, disruption of ecosystem stability in the surrounding area, diminished livestock productivity, and exposure of mine personnel to a higher risk of respiratory disorders. Application of best available control technology would be about 74-percent effective in controlling fugitive dust.

There would be reduced productivity, infiltration, and permeability of topsoiled materials, which in turn would affect vegetation and wildlife production. Soil organic matter would be reduced by a factor of 2.5 and the downward percolation of water would be reduced by a factor of 1.5 to 3.5. Redevelopment of natural soil profiles would require a long period of time, on the order of decades or even centuries. There would also be the unavoidable destruction of the existing vegetation mosaic and species diversity, lasting for an unknown length of time, perhaps decades or even centuries. Several plant species necessary to some wildlife would be difficult to reestablish. Although sagebrush may be reestablished, it would not be planted in densities required for establishment of some premining wildlife populations. Mule deer winter range would consequently be reduced by about 400 acres. There would be unavoidable habitat losses that would lower the wildlife carrying capacity of the area that may last for decades or longer. Available livestock forage would be impacted for a shorter period of time. Lands would be removed from grazing during the period of active mining. Approximately 170 to 300 AUM's per year may be lost for the 7-year life of this mining plan.

The population growth, 163 people, associated with this mine, is expected to be concentrated in Forsyth and would contribute to a 7-percent increase in population by 1985. These people would be fairly easily absorbed into the community causing little additional stress to community services. If any of this growth, however, were to occur in Lame Deer, there would be a significant impact. Lame Deer is not able to easily absorb new growth.

There would be increased highway usage between Forsyth and Colstrip resulting in more congestion, higher maintenance costs, and increased traffic accidents and injuries until such time as construction or reconstruction is undertaken by the Highway Department. At full production, 416 unit-train trips per year, twice the present traffic load on the 7.5 mile spur to Colstrip would unavoidably increase blocking times at grade crossings. There would also be a two-fold higher incidence of noise, dust, and gaseous air pollution along the right-of-way from the mine to Colstrip. All of this may constitute a decline in esthetic value to some observers. Other unavoidable esthetic impacts of mining as proposed would include the removal of some buttes or small mesas, steep banks, and draws in the lease area. This could be mitigated by leaving segments of unreduced highwall; however, this is not proposed by Peabody Coal Co. There would also be an insignificant increase in overuse, trespassing, poaching, and vandalism.

CHAPTER VI

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

THIS CHAPTER DISCUSSES THE EXTENT OF LONG TERM IMPAIRMENT OR ENHANCEMENT OF RESOURCE VALUES THAT WOULD OCCUR, GIVEN THE SHORT TERM USES OF THE ENVIRONMENT PROPOSED IN PEABODY COAL COMPANY'S MINE AND RECLAMATION PLAN. IN THIS ANALYSIS, EMPHASIS IS PLACED ON THE LONG TERM ENVIRONMENTAL COSTS OF MINING COAL, AS PROPOSED, FOR THE PURPOSE OF SHORT TERM USES.

CHAPTER VI

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The Big Sky-Colstrip area, having experienced surface coal mining for many years, has a present annual production of approximately 13 million tons. The Big Sky expansion would nearly double the production of this mine from about 2.3 to 4.2 million tons per year. It is anticipated that the coal industry will continue to grow, depending on a continuing market demand for low-sulfur subbituminous coal. By 1985 the combined production from the Big Sky and Rosebud (Western Energy) mines is projected to be about 18.5 million tons, 19 percent of which would be from the Big Sky mine. Matson and Blumer (1973) estimated that approximately 1.4 billion tons of coal reserves remain in the Rosebud seam of the Colstrip deposit; thus, mining could conceivably continue within the area for many decades.

The proposed short-term use of the Big Sky permit area is the mining of approximately 30 million tons of coal from 894 acres within a permit area of 1,264 acres. Long-term environmental costs of mining at Big Sky under the proposed mining and reclamation plan would be primarily the additional physical disruption of the ecosystem adjacent to the ongoing mining operation--destruction of the soils, vegetation, wildlife, and hydrologic regime.

The local short-term use of the Big Sky mine permit area would lower its long-term biological productivity. The geomorphic instability and erodibility of the reclaimed land surface (894 acres) would result in a loss of topsoil and a decrease in potential productivity. Water infiltration on the reclaimed land surface would decrease, causing increased runoff and sedimentation for an unknown period of time. Much of this runoff would probably collect in closed depressions and would not leave the reclaimed surface. The water supply to one pond would be lost, and the one spring's flow may decrease. It is unknown if mining would affect subirrigation to Snider's alfalfa field.

Initial productivity following seeding on mined surfaces would be very high, reflecting nutrient releases caused by soil disturbance. This would be reduced dramatically after 3-5 years. Long-term productivity would depend to a large extent on the level of management applied both before and after bond release.

There would be a loss of the vegetation mosaic and species diversity in the mined-out area for a long (but unknown) period of time. Ponderosa pine, a number of broadleaf deciduous trees, and some shrub species would take several years to reestablish at premining levels, therefore reducing the quantity and quality of postmining wildlife habitat.

The most significant impacts to air quality on the minesite would last for the life of the mine and would thus be short term. A long-term source of fugitive dust from the minesite would be wind erosion of reclaimed surfaces, until stabilization occurs. The area surrounding the mine would serve as a long-term depository for atmospheric effluent from the mining operation and could consequently be less productive. Long-term sources of fugitive dust remote from the minesite would include town expansions due to the expanded mine.

Short-term gains would be experienced from the extraction of coal. These include: electrical generation, and increases in employment, income, and revenue in the regional area, and profits for the coal company. The long-term economic effect on agricultural activities at the minesite is unknown. On a regional basis it would not be significant.

There would be a long-term investment in land uses resulting from the Big Sky mine expansion. Land committed to residential, commercial, and service facility development, primarily in Forsyth and Colstrip, would not necessarily revert to present uses after the mine closes. The value of the natural landscape for esthetic, historical, and archeologic purposes would be lost for the long term. Any improvements in the highway system as a result of the mine expansion would have long-term benefits for the local population. The mine expansion would cause an additional increment of use and, thus, financial support for the regional public transportation systems, especially air and bus service.

The effects of overuse, trespassing, poaching, and vandalism as a result of increased population and recreational pressures would last for an undetermined length of time and would be minor due to the relatively small amount of population growth attributed to the mine. Scenic values would be lower for the long term. Undiscovered cultural resources that would be destroyed by mining would be nonrenewable.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

THIS CHAPTER QUANTIFIES THOSE RESOURCES THAT WOULD BE CONSUMED OR LOST AS A RESULT OF PEABODY COAL COMPANY'S PROPOSED MINE EXPANSION.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

During the 7-year life of the proposed mine expansion, approximately 30 million tons of coal would be extracted from two coal seams for the purposes of electrical generation. Mining activities would commit about 894 acres of the 1,264-acre permit area to mining level disturbance. Reclamation of this area, especially for environmental factors, such as soils, vegetation, and wildlife, would take many years--decades, or even centuries--to accomplish. During mining 411,000 gallons of diesel fuel and 32,500 gallons of gasoline would be consumed annually. The rate of electrical power use would be equal to or greater than the present rate, which, projected from the 1974 Big Sky mine EIS (USGS, FES 74-12) was estimated at 16.6 million kW per year.

Although records of water consumption are not available, it is estimated that 10 acre-feet per year per million tons of coal mined is used for mining purposes. This would amount to 42 acre-feet for the proposed level of coal production. Water for domestic and sanitary purposes, approximately 3 million gal/yr, (FES 74-12, p. 41) would continue to be pumped from the two wells northwest of the mine shop. The addition of 32 employees is not expected to increase water requirements appreciably.

Three ground-water aquifers--the Rosebud and McKay coal seams and a permeable sandstone in the overburden--would be destroyed within the area to be mined. The total dissolved-solids concentration in water from the resaturated spoils would probably increase to 3,880 mg/L from premining levels of 1,270 mg/L. This threefold decrease in water quality would preclude the use of water from the spoils for either livestock or domestic use, unless better water could not be obtained. Better water, however, is available both from outside the proposed mine area and from deeper aquifers. Stream channels flowing over regraded highwalls and across reclaimed spoils would irretrievably alter the erosional and depositional characteristics of the minesite.

Air quality would continue to exceed EPA standards in the nonattainment area and, unless Peabody offsets their increased emissions, air quality (for the life of the mine) would further exceed air quality standards.

The productive capacity of the reclaimed soils would be lower because of disruption of the soils' physical, chemical, and geological characteristics. The existing vegetation mosaic and species diversity could not be replaced. In response to these factors, the carrying capacity for wildlife would be reduced for many decades or longer.

Any sandstone bluffs removed during overburden removal would be irretrievably altered, precluding reestablishment of wildlife cliff

habitat. Potential raptor nesting sites and winter range of mule deer would be eliminated. Topography would be greatly altered, and developments off the mine site would remain after mining, creating a permanent visual impact.

The continuing transformation from a traditional way of life appears for some people to be irreversible. Time and money invested in mining and offsite developments would be irretrievably committed. Energy, materials, and labor used in the mining operation would be lost to other uses.

There is no precedent for the reconversion of residential or urban-type land uses to agricultural land.

Any cultural resources left undiscovered before mining would be irretrievably lost due to mining.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

THIS CHAPTER DESCRIBES REASONABLE ALTERNATIVES TO PEABODY COAL COMPANY'S PROPOSED MINE AND RECLAMATION PLAN.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

Various alternatives to the approval of the Big Sky mine expansion as proposed can be selected by the Secretary of the Interior and the Montana Commissioner of State Lands when it is deemed necessary to further reduce impacts of the proposed mining or to comply with legal requirements and the lease terms. The mining and reclamation plan and subsequent modifications must be approved by both the Secretary and the Commissioner. The alternatives that apply to the Big Sky mining proposal include those resulting from the administration of existing regulations of the Federal and State regulatory agencies. The options available to these agencies, as provided by existing legislation, and the resulting impacts of exercising these options are discussed below.

A. ADMINISTRATIVE ALTERNATIVES AVAILABLE TO THE SECRETARY OF THE INTERIOR IN RELATION TO FEDERAL LEASES AND MINING AND RECLAMATION PLANS

1. No Action

Pursuant to implied covenants of both the Federal mineral leasing laws and the existing lease agreements, the Secretary is obligated to respond to a legitimate application to conduct mining operations on a valid lease, provided that all terms and conditions thereunder have been met. His response may be approval as proposed, rejection on various legitimate grounds, approval in part and rejection in part, or approval subject to such additional conditions and requirements or modification as he may impose under the laws. He may also defer decision, based on proper grounds, as described elsewhere in this chapter.

The impacts of taking no action would be the same as described subsequently under subsection 3, "Prevent further development on existing lease."

2. Defer Action

For proper cause, the Secretary may defer final action on this proposed mining and reclamation plan. These could include, but are not limited to, the need and time required for:

1. Modification of the proposal to correct administrative or technological deficiencies.

2. Redesign in order to reduce or avoid environmental impact.

3. Acquisition of additional data to provide an improved basis for technical or environmental evaluation.

4. Further evaluation of the proposal and/or alternatives.

The principal effect would be the temporary closing of the Big Sky mine. The secondary effect of deferring action on a proposed mining and reclamation plan on these grounds would be a comparatively short-term delay in the imposition of most related impacts of the proposal as previously described in the unavoidable, adverse impacts section of this statement.

After a mining and reclamation plan is approved, the regulations (SMCRA regulation 30 CFR 700) also permit the OSM to direct that changes be made in previously approved operations. For example, changes could be ordered to accommodate new, improved, or revised administrative requirements, technological improvements, environmental concerns or requirements, or revisions of prior evaluations thereof in the light of experience or unknown factors.

3. Prevent Further Development of this Lease

The only alternatives to allowing development of the existing lease are those which prevent such development or which impose additional conditions and restrictions on the operation. The several apparent means of preventing full development are discussed below.

If prevention of further development of the existing Federal lease were accomplished, it would cause at least temporary closure of the Big Sky mine, until non-Federal leases could be developed. Substantial quantities of coal known to be present would be left in place and would probably be by-passed. To replace the resources foregone by this alternative course of action, other comparable quantities of coal would probably be required to meet company contract commitments.

a. Suspend operations

The full development of the existing lease could be delayed by suspension of operations. If such action were taken, the company would undoubtedly strive to develop non-Federal leases to maintain its production and employment levels. There would be no additional incremental impact to the physical environment due to disturbance of the Federal lease, and this lease would continue in its present condition, subject to further modification by natural processes, the continuation of nearby mining activity, and such further uses of the surface as the owners may decide. There could, however, be adverse social and economic impacts resulting from unemployment due to the closure of the mine.

The authority of the Secretary of the Interior to suspend operations has been utilized on other leases in the past, and future suspensions

of operations for reasonable periods, with proper grounds, could be imposed. The Secretary cannot, under present circumstances, suspend operations to the extent that a de facto cancellation of a lease results unless he seeks and obtains additional authority from Congress. Viability of this option is dependent upon timely legislative action; the option of suspending operations pending legislation remains available. Impacts of this alternative would similar to those described in subsection VIII-3-b, "Cancel the leases."

b. Cancel the lease

The Secretary does not possess authority to unilaterally cancel the Big Sky lease except on the grounds defined therein (section 7 or 8 of the lease terms--"Proceedings in case of default"). The authority to cancel on other grounds would require Congressional authorization for such action, as well as for the requisite funds for compensation of the lessees as may be necessary. The Administration has not entered a request for such legislation, and the Congress has not initiated such action in the matters considered in this statement. The possibility of such action is a matter for further consideration by the Administration and the Congress in the light of this environmental statement and other relevant nonenvironmental concerns.

To the extent that coal production from the existing lease is curtailed or halted, alternative sources of energy would be required to meet present needs and demands. These could be foreign and/or domestic and are discussed on later pages. The time required to replace the resource foregone could range from scant to a number of years, depending on the specific alternative(s) selected.

If this lease were to be cancelled through Congressional authorization, the physical, esthetic, and socioeconomic impacts stemming from the proposed mine would be altered, depending upon the further mining of non-Federal coal. Conversely, should development eventually be authorized, environmental impacts as discussed in chapter III would occur. The net result would be a deferral and perhaps reduction of impacts through improved technology or requirements imposed at that time.

c. Federal acquisition of this lease

The outstanding leasehold interests could be acquired by the Secretary. The ability to acquire the leasehold interests is not granted by the existing relevant statutes and would require Congressional authorization for such action, as well as for the requisite funds for compensation of the lessees. To date, the Administration has not requested such action, and the Congress has not initiated or considered such legislation; the possibility thereof is thus conjectural at best. The major effects of such Congressional authorization would be similar to those of cancellation of the lease as previously discussed under subsection 3 (b).

d. Reject this mining and reclamation plan

The Secretary may reject any individual proposed activity that does not meet the prescriptions of applicable law and regulations under his authority, including the potential for environmental impact that could be reduced or avoided by adoption of a significantly different designed course of action by the lessee (operator). Except when a mine plan does not comply with existing regulations, the Secretary cannot under present circumstances reject the proposed plans to the extent that a de facto cancellation of a lease results. Impacts of this alternative would be similar to those described under subsection 3 (b), "Cancel the lease."

Rejection of the proposed mining and reclamation plan for the Federal lease would probably be offset by the development of mining and reclamation plan covering non-Federal coal leases, as described above. This could lead to the bypassing of Federal coal which, in this area, underlies even-numbered sections having a "checkerboard" map distribution. If non-Federal coal were mined in a checkerboard pattern on alternate sections, the environmental costs could increase and a significant amount of recoverable Federal coal would be forfeited.

4. Restrict Development of this Lease

The subject lease conveys the right to develop, produce, and market the Federal coal resource thereon if all other terms and conditions have been met by the lessee. In general, the Secretary does not possess the authority to arbitrarily constrict development. Various measures that may tend to restrict development may be taken by the Secretary at any time in the interest of conservation of the resources or in the protection of various specific environmental values in accordance with existing laws and regulations, such as the National Historic Preservation Act of 1966, the Endangered Species Act of 1973, and the Clean Air Act of 1977.

Thus, under present conditions, a general effort to restrict or regulate development of the existing lease for reasons other than that of failing to comply with existing laws and regulations would constitute a selective application of the "prevent development" alternative already discussed; that decision, as it relates to impacts, possible litigation, and the need for authorizing legislation, would be relevant in this instance.

5. Approve the Mining Plan After Modification

A number of the impacts identified and described in chapter III of this statement could be more fully mitigated by the selective application of those measures described that are supplemental to the proposal of the Peabody Coal Company or by implementation of one or more of the alternatives described below. Among the more obvious options to be considered are changes in mining procedures and production rates, and coal transportation systems. Such modifications could include any

that might be imposed by the State of Montana and the Secretary in the approval process. In addition, special conditions could be added to the approved plans that would mitigate or control secondary effects of mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the lease areas with the resultant impacts previously discussed under subsection VIII-3-d, "Reject this mining and reclamation plan."

6. Allow Development of Selected Areas Now Under Lease

This alternative would permit only selective exploration and development of the existing leasehold, based on anticipated adverse environmental consequences. The decisionmaker has the authority and responsibility to evaluate the coal resources and impacts of mining on the lease prior to acting on the proposal. Exploration and development could be allowed only on the leasehold, or portions thereof, that would have the lowest anticipated adverse environmental consequences. Weighing the tradeoffs of mining or precluding mining on selected tracts are part of the evaluation and decision making process. Adoption of this alternative would reduce adverse effects by reducing the area in which the impacting activities could take place.

The alternative of allowing the development of only selected areas already under lease constitutes a selective application of the alternative of preventing further development of the existing lease described above. The Secretary possesses the authority to constrain development of the leasehold in the absence of proof that the lease or plan could reduce, to an acceptable level, those wholly unacceptable environmental impacts. In addition, application of this alternative would be contrary to principles of conservation embodied in the legislation which authorizes the leasing of Federal coal lands for the purposes described. It is entirely possible that such selective mining would leave isolated blocks of coal that might never be recovered owing to the high costs of mining such remnant areas at a later date.

B. ADMINISTRATIVE ALTERNATIVES AVAILABLE TO STATE AGENCIES

1. Department of State Lands

The authority for State action regarding mining and reclamation rests with three laws:

(1) Montana Strip and Underground Mine Reclamation Act
(2) Montana Strip Mine Siting Act
(3) Montana Strip-Mined Coal Conservation Act

The State does not have an equivalent to the Federal "no action" alternative. If, in fact, no action were taken by the Department within 240 days after receipt of a complete application for a mining and reclamation permit, the permit would be statutorily approved, by default.

The State also does not have a formal administrative alternative to "defer action" following the receipt of a completed application for a mine and reclamation permit. However, the State may deem an application incomplete due to a failure of the mine and reclamation plan to meet State requirements, leading to a postponement of the action, which has the effect of deferral.

Other than the decisions to approve or disapprove a permit, only two viable alternatives are open to the State: (1) approval of the permit with modification; and (2) selective denial of the permit to mine in a specified area that includes lands having special, exceptional, critical, or unique characteristics, or where mining would affect the use, enjoyment, or fundamental character of neighboring land having the above special characteristics. Either or both of these alternatives, which could be legally invoked after the permit application was deemed complete, would generally be exercised by the Department during its review of the application, thereby making modification and/or selective denial prerequisite to the acceptance of a completed application. The State plays a larger role than the Federal government in the process of planning, before action is required on specific mine and reclamation permits.

Impacts that would result from rejection of the Big Sky permit application could be different from those discussed under the Federal administrative alternative of preventing development of the existing lease, because the State authority extends to proposed operations on non-Federal as well as to Federal leases. This could preclude the checkerboard mining of non-Federal leases. Impacts that would result from approval of the permit are those analyzed in chapter III. Impacts that would result from modification of the permit application, or from selective denial of the permit to mine in certain areas, are similar to those discussed under Administrative Alternatives available to the Secretary of Interior.

2. Department of Health and Environmental Science

The Montana Clean Air Act is the law under which the Department of Health and Environmental Sciences would exercise its authority to take action on the application for a permit to operate coal-handling facilities at Big Sky, in order to insure that the best possible control technology would be applied toward preventing and abating air pollution.

Three administrative alternatives open to the Department are disapproval, approval, or approval after acceptable modification of the construction and/or operating designs.

Decisions of the Department of Health and Environmental Sciences are not contingent on those of the Department of State Lands, with the result that disapproval by either Agency would cause rejection of the entire project. The impacts due to disapproval of the permit for coal-handling facilities would therefore be the same as those from

rejection of the mine and reclamation permit. Impacts due to approval of the coal-handling facilities are those analyzed in chapter III. Impacts that would result from modification of the designs for construction and/or operation of coal-handling facilities are discussed under Technical Alternatives.

For other permitting responsibilities by the State and Federal agencies, see table I-1.

C. ALTERNATIVES PROPOSED BY PEABODY COAL COMPANY

In response to the June 5, 1978, letter to the company from the Montana Department of State Lands (appendix P), Peabody turned in an application for 29.04 acres (fig. VIII-1). This area, located in sec. 22, is part of the 1,264 acres analyzed in this impact statement (chapter I). Peabody wishes to change their bonding on this area from "associated disturbance" to "mining level disturbance," and mine. The purpose of this proposal is to provide an area in which to expand, thus keeping the mine open until permit for the complete acreage can be obtained.

The effect of granting Peabody a permit for this smaller area is insignificant. The impacts, as listed in the Summary at the beginning of this statement, would change. Hydrologic, vegetative, and associated impacts would be significantly less if Peabody were to mine only these 30 acres.

Administrative alternatives to be considered for the smaller acreage are the same as those to be considered for the entire acreage. Peabody may be able to obtain a separate permit sooner than they would obtain a permit for the entire acreage.

D. TECHNICAL ALTERNATIVES

Technical alternatives may be required as stipulations to a permit.

Modifications, such as different mining procedures, changes in the mine configuration, changes in the method of transport, or development of selected areas now under lease, have been considered. It does not appear, however, that these options would significantly alter the impact of mining the Big Sky lease, and, indeed, many of these options are not viable. Many of these changes may also change production rate but the production rate would not change the overall impact. If any such alternatives are suggested in the review process, they will receive consideration in preparation of the final environmental statement.

The alternatives, discussed below, may be required by the permitting agencies as stipulations to the permit and would constitute an approval of the mining and reclamation plan described in chapter I, with modifications.

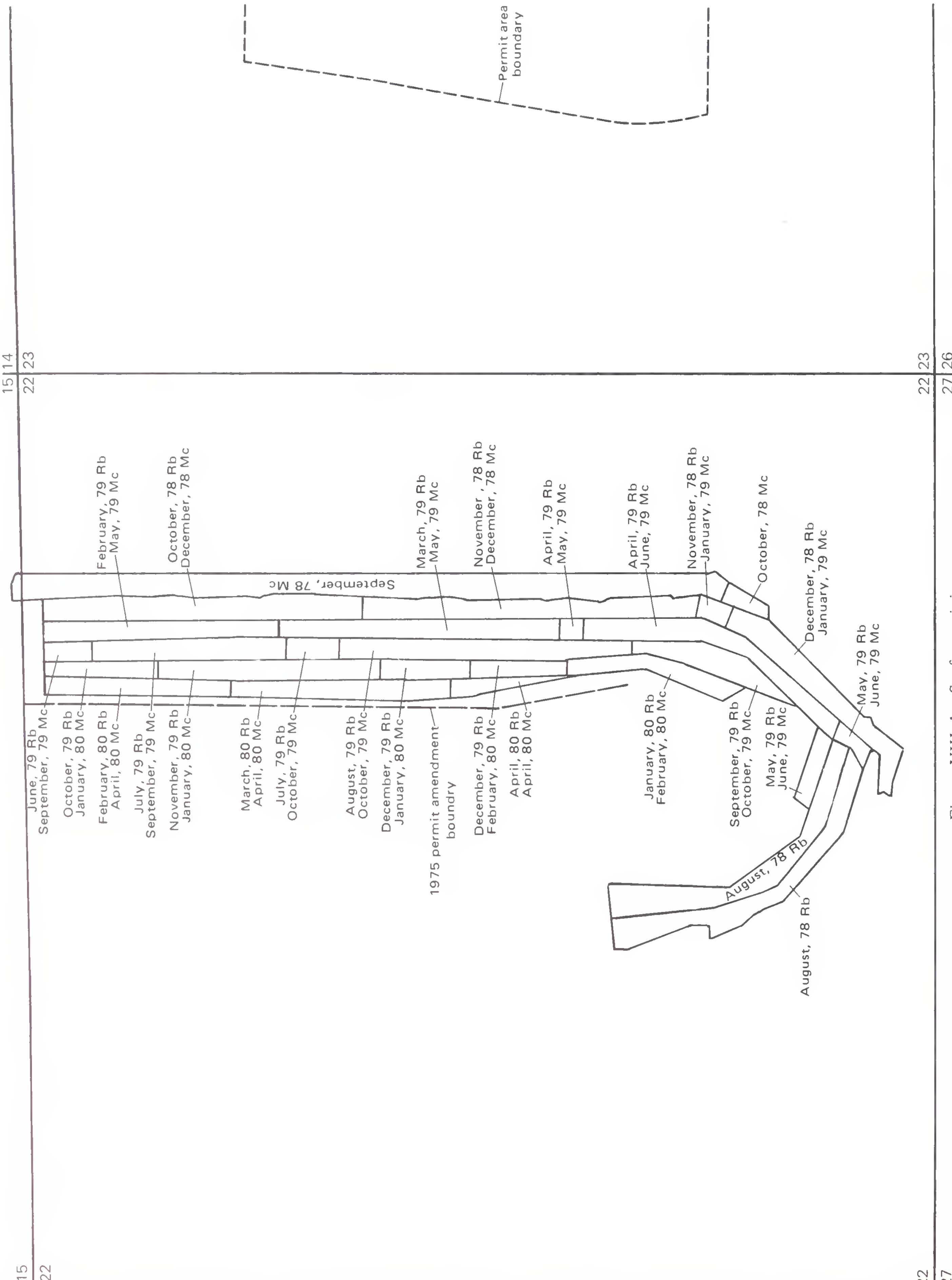

Figure VIII-1.--Surface mining sequence.

1. Geology

a. Topography and geomorphology

During mining, impacts can be reduced by:

1. Designing the proposed diversion channels for higher intensity, shorter duration storms. This would lessen the likelihood that uncontrolled erosion would occur on and off the minesite.

2. Controlling the rate at which storm waters caught in settling ponds are discharged to the downstream drainage in order to avoid erosion.

The susceptibility of the reclaimed surface to increased erosion and deposition can be reduced by:

1. Reducing slope lengths.

2. Returning all premining ephemeral channels to the reclaimed surface (this would aid in reducing slope lengths).

3. Designing the reclaimed surface to accommodate anticipated subsidence.

4. Placing topsoil upon a roughened spoils surface to inhibit flow along that boundary and to increase downward percolation.

5. Removing all settling ponds as a part of final reclamation.

2. Hydrology

a. Surface water

Mitigations proposed above would serve to reduce excess sedimentation.

b. Ground water

If the alfalfa field in sec. 24 is adversely affected, pumping from the mine pit could be regulated to avoid the effect. Should the amount of water moving to the alfalfa field need to be reduced, this could be accomplished by more frequent pumping from the pit, and vice versa. The amount of water moving toward the alfalfa field could also be controlled in part by selection of the point of discharge of water pumped from the pit. Water pumped to the western siltation pond is likely to reduce the flow to the alfalfa field, and water pumped to the eastern siltation pond is likely to increase the flow to the alfalfa field.

3. Air Quality

Additional technical methods that could be stipulated by the Federal or State governments to control fugitive dust could include the following:

a. Coal handling facilities. The installation of bag houses on the ventilating system of the coal-storage barn would increase the dust control efficiency of the barn. Completely enclosed crushing and conveyor systems would eliminate the resuspension of coal dust from beneath the conveyor. Together the bag houses and the covered crushing and conveying systems would decrease the potential fugitive dust emissions from these sources by 99.8 percent (U.S. EPA, 1976a), a 73-percent increase over proposed control technologies. Midwestern power companies have already complained of substantial coal losses (about 1 to 3.5 percent or up to 385 tons, about four carloads per unit-train) in transit. (Chris Cull, oral comm., 1978). A negative pressure truck dump, installed above the primary crusher, would decrease the amount of escaping dust (control efficiency unknown). A hot oil spray would reduce coal dust loss from unit-trains. This would decrease regional fugitive dust from trains by 87.9 percent (Nimerick and Laflin, 1977). Covers for coal cars would also reduce fugtive dust. Coating coal with another fossil fuel increases the total amount of air pollutants during combustion and increases the cost of power to consumers.

b. Area sources. Topsoil piles which are ephemeral could be best stabilized against wind erosion with a mulch, since vegetation must establish a dense cover before it becomes effective. The elimination of unnecessary roads from the mine area would decrease fugitive dust and revegetation.

c. Immobile point sources. Dust contained within the cyclone dust collectors on drill rigs could be deposited back in blast holes to prevent wind erosion from unstable piles.

d. Mobile sources. A mass transit system for mine employees from Forsyth would decrease traffic-related emissions in town, along the Armells Creek drainage, and at the minesite. Overloading of coal haulers increases fugitive coal dust from the haul roads. This could be practically mitigated by decreasing loads (in accordance with EPA and Montana Air Quality Bureau guidelines).

Alternative or additional air quality monitoring systems could be stipulated:

As mining progressed northward and eastward, additional air samplers could be installed to adequately monitor these activities. One monitor could be placed outside the permit area on the Jim Snider Ranch. The monitor could be placed far enough from the mining activities so as to

not accumulate excessive amounts of large particles. This would be an excellent location for a cascade impactor, a high-volume sampler, and periodic trace element analyses, since this is a place where people and agricultural activities are located. A second high-volume sampler, and a dustfall sampler could be placed beyond the powder magazine site in the Emile Coulee drainage. This would indicate the magnitude of TSP leaving the permit area and deposition onto the productive drainages. It is assumed that the other four monitors would remain intact for purposes of record and periodicity of air quality. If any air monitors had to be removed, the substation and the powder magazine sites could be eliminated.

Alternative State regulations for air quality control at strip mine:

Attainment of the National Ambient Air Quality Standards in the Colstrip area requires that the Air Quality Bureau devise acceptable regulations which would effectively reduce fugitive dust from strip mines. Since the Peabody Big Sky mine expansion would increase particulate emissions of the area, these emissions must be "offset" by similar reductions. "Offset" may be achieved by decreasing dust at both the Big Sky mine and the WECO mines. PEDCo (1977) recently showed that fugitive dust from the strip mines at Colstrip was the greatest contributor to the air quality problem.

In a situation such as this, where existing strip mines are in violation of the air quality standards, the following stipulations could be imposed:

1. Use best available control technologies for all fugitive dust sources (coal storage facilities, covered coal crushing and conveying, watering haul roads, etc.).

2. Include air quality monitors which are representative of ambient air (enforcement control).

3. Require detailed mining sequence forecasts, and activity reports, so that accurate emissions inventory can pinpoint fugitive dust problems vis-a-vis the air quality monitoring system.

4. Soils

a. Management alternatives

At the time of bond release, the legal requirements for reclamation would be met. However, in practical terms, it is unlikely that the postmining surface would be capable of reintegration into normal land use patterns without significant deterioration. Under these circumstances, continued monitoring of the soil and range condition should be considered, to assure the long-term success of reclamation.

Given the unstable and fragile nature of surface mine spoils and the relationships between "topsoil" materials, vegetation, topography, wildlife habitat and surface processes, it is imperative that reclamation procedures reflect the state of the art. Toward that end, it could be stipulated by the Federal and/or State governments that the following alternative techniques be applied for handling spoil materials:

1. Remove "topsoil" materials by a double lift: the first pass would take "A" and "B" horizon materials. Materials from "C" horizons would be taken on subsequent passes. This would preserve a relatively high percentage of soil organic matter in the final reclaimed surface, enhancing hydraulic characteristics of "topsoiled" spoils; it would also maintain highest possible cation exchange capacity, contribute to the relatively rapid reestablishment of soil structure, and avoid the high levels of soluble magnesium frequently found in "C" horizon soil analyses.

2. Apply a deep rip, rather than grading and smoothing, to the surface of overburden spoils prior to placement of "topsoil" material from "C" horizons. A second light ripping would follow placement of "C" horizon material, followed by placement of "A" and "B" "topsoil" material. This sequence of preparation procedures would do more than simple grading to ensure adequate contact between unlike materials for maximum hydraulic conductivity. This should reduce otherwise serious problems with spoil water recharge, root matting at interface surfaces, saturation, and piping.

3. Examine the inventory of soil resources much more intensively to allow maximum salvage of "topsoil" material and to minimize inclusion of undesirable materials.

4. Redesign the final surface topography to include terraces. This would shorten slope lengths to reduce erosion. (See Topography and Geomorphology.) Terraces, if properly designed, would also facilitate infiltration of surface water. The establishment and survival of ponderosa pine may be encouraged through the use of terraces and specialized sylvicultural treatments to reduce competition. Such treatments could include salvage of the Ringling channery loam "A" horizon, which contains up to 30 percent rock fragments, and heavy mulch applications around planted trees.

5. Vegetation

a. Fertilizer

Among the technical alternatives that could be stipulated as mitigatory measures by the Federal or State governments are the following:

1. Apply fertilizer, if indicated by test results.

2. Limit reclamation use of topsoil and nontoxic substrate to material not exceeding 2 ppm molybdenum content. This has been proposed by Miles City BLM, after consultation with several State and Federal agencies and institutions, as being the soil suspect level for the element.

b. Seeding

1. Reduce alfalfa and yellow sweetclover seeding rate to 1/2 pound or less per acre, to prevent crowding out of grass seedlings.

2. Plant more species required for winter range of mule deer.

3. Inoculate, with the proper bacteria, all legume seed within 48 hours (Anonymous, 1977) prior to planting. Inoculations of legumes by the proper strain of Rhizobia bacteria can insure natural nitrogen availability in the soil as legumes decompose in the soil (Vallentine, 1971). This available nitrogren would be necessary after that from initial artifical fertilization has been depleted.

   The applicant proposes to use legumes to supply nitrogen to other nonleguminous species. Experience elsewhere indicates that this may not be adequate. Further, this does not address the problem of phosphorus deficiencies that would most likely occur.

4. Drill seeding would probably be more effective than broadcast seeding.

c. Postseeding management

1. Grasshoppers are the only insects that appear to present any problem on reclamation, particularly because the exposed soil surface presents a favorable egg-laying condition. A stipulation would be imposed to implement measures for control of these insects.

2. Protection of shrub and browse species from grazing by wildlife, until the plants are well established, could promote reclamation.

3. Mulching of all reclaimed surfaces, regardless of slope grade or length, would prevent crusting of the soil surface, thereby enhancing seeding emergence. Erosion would also be reduced.

6. Wildlife

Tree and shrub species valuable to wildlife could be planted on revegetated areas in densities similar to those existing before mining.

Game management areas could be established on reclaimed lands or other Peabody Coal Company lands adjacent to the mining area.

Human activity in areas not being mined could be kept to a minimum to reduce wildlife disturbance.

Variances to the State of Montana reclamation laws could be sought to the benefit of wildlife, i.e. retaining highwalls and water bodies.

Artifical raptor nests, such as kestrel boxes could be constructed.

Specially designed fences around reclamation areas should be constructed to allow for the free movement of antelope.

Rock outcrops (fig. II-15) should be left undisturbed wherever possible to preserve valuable bird habitat.

7. Esthetics

An alternative for reduction of visual impacts would include the painting of buildings, equipment, etc., with neutral colors which blend with the surroundings. Visual impacts would also be reduced if fugitive dust were more stringently controlled, and if seeding mixtures used in reclamation contained plant species more similar to vegetation in the unmined, adjacent areas.

E. SOCIAL AND ECONOMIC IMPACT ALTERNATIVES

The Secretary of the Interior could direct that the Department evaluate and respond to the following suggestions to mitigate the socioeconomic impacts or to other suggestions made by reviewers and local government agencies. In addition, the Secretary could implement any resulting mitigations that are within the Department's authority and are in the best interests of the local and Federal Government. The Secretary could direct that the Department expeditiously develop rules and regulations and seek appropriation for the loan program to impacted communities authorized in an amendment to the BLM Organic Act (P.L. 94-579). In addition, the Secretary could encourage Rosebud County to seek low-interest loans from the Department to finance facilities needed to mitigate impacts resulting from approval of expanded mining in Big Horn County.

The State of Montana Coal Severance Tax could help alleviate problems in Montana. The Montana Coal Board (appointed by the Governor) disperses such funds in the form of loans and grants.

Federal assistance for impacted areas is also available for specific categories. The U.S. Department of Energy has made a list of assistance by category. For further information, this list is on file at the office of the U.S. Geological Survey, EIAP, Box 25046, Mail Stop 701, Federal Center, Denver, Colorado 80225.

Further impact-assistance is pending in Congress and may be made available later.

There are a variety of technical alternatives for providing water, sewer, and other public services. Some of the most important alternatives which need exploring are ways to get sufficient funding where it

is needed, when it is needed, and at the same time preserve equity and prevent over-capitalization.

Several common schemes are applicable to this situation: prepayment of taxes, intergovernmental tax sharing, and state funding mechanisms. Corporate prepayment of taxes has been used in several instances, however, in Montana, corporations feel that the 30 percent severance tax should pay for all impact mitigation, and the State is reluctant to do anything further. It is also true that for a given corporate expenditure, local governments get twice as much revenue from production, or severance taxes, than from prepaid taxes. This is due to the nature of Federal tax codes under which prepaid taxes become capital investment and are depreciated. Companies are therefore more willing to have money taken from production. There is also a problem with the spatial distribution of impact. It may be difficult to allocate prepaid taxes to the governmental entities which will actually experience the impact.

Another alternative solution is intergovernmental tax sharing, which avoids some of the problems of the first solution. Montana has the Interlocal Agreement Act, which allows local governmental entities to join together for specific tasks. This is often used for joint planning programs or construction of a joint facility. It is very unlikely, however, that this method would be used to funnel money from the tax base to the impact area. Such tax sharing would almost have to be imposed by the state to overcome local political problems.

The potential exists for mitigation of adverse impacts produced by population growth by implementation of land use planning. Rosebud County has created a land-use planning board which could mitigate impacts through the adaption of county subdivision regulations.

CHAPTER IX

CONSULTATION AND COORDINATION

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CONSULTATION AND COORDINATION

A. ORGANIZATION OF STATE AND FEDERAL INTERAGENCY TASK FORCE FOR THE ENVIRONMENTAL STATEMENT

Instructions to prepare regional and site-specific environmental statements for the Northern Powder River coal basin were issued to the Geological Survey and the Bureau of Land Management by the Secretary of the Department of the Interior on April 29, 1976. The Geological Survey was designated as lead agency. Because of some duplicate or closely related actions pending before Federal and State agencies, and because of the Montana Environmental Policy Act, the State of Montana joined with the Federal task force in September 1976 in the preparation of these environmental statements.

B. DEVELOPMENT OF THE STATEMENT

Public notice was given in November 1977 that an environmental impact statement was to be prepared on the proposed Big Sky mine expansion mining and reclamation plan by a joint State-Federal task force. The State task force personnel were under the administrative supervision of a State coordinator attached to the office of the Commissioner of State Lands. On July 5, 1978, a directive was issued by the U.S. Department of the Interior and the Montana Department of State Lands to issue the Big Sky site-specific EIS as a separate document, in advance of the regional document.

In preparation of this draft statement, data and/or review comments were solicited from a wide range of State and Federal agencies, county and city officials, consultants, and private interest groups.

A close working relationship was established with State and local agencies in Montana. All divisions of Montana State government having jurisdictional interests in the projects have been contacted and many have supplied data.

During the preparation of this preliminary draft environmental impact statement, consultation and coordination was made with the following organizations:

Government:

Department of the Interior:
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Reclamation
- Fish and Wildlife Service
- Heritage Conservation and Recreation Service
- National Park Service
- Office of Surface Mining

Other Federal Agencies:
- Department of Agriculture
  - Forest Service
  - Soil Conservation Service
- Department of Commerce
  - Old West Regional Commission
- Department of Energy
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of Labor
  - Mining Safety and Health Administration
- Department of Transportation
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- Interstate Commerce Commission
- President's Advisory Council on Historic Preservation

State of Montana:
- Office of the Governor
- Agricultural Experiment Station
- Bureau of Mines and Geology
- Department of Community Affairs
- Department of Fish and Game
- Department of Health and Environmental Sciences
- Department of Natural Resources and Conservation
- Department of Revenue
- Department of State Lands
- Energy Advisory Council
- Environmental Quality Control
- State Historic Preservation Office

Local:
- Rosebud County Planning Director
- Board of Commissioners, Big Horn County, Montana
- Board of Commissioners, Rosebud County, Montana

State of Wyoming:
- Office of the Governor
- Board of County Commissioners, Sheridan County, Wyoming
- Mayor, City of Sheridan

Non-Government:

Burlington Northern Railroad
Ecological Consulting Service, Inc.
Meadowlark Group
Milwaukee Railroad
Montana State University
Mountain Bell Telephone Company
Northern Cheyenne Research Project
Northern Plains Resource Council
Old West Regional Commission
Peabody Coal Company
University of Montana
Yellowstone-Tongue Areawide
Planning Organization

The Peabody Coal Company provided data and information on their proposed activities and greatly facilitated field observations and data collection by task force members.

Archeological reconnaissance of the Federal lease (sec. 14) was provided by the contractural services of Anthropologis Research International, Inc., of Livingston, Montana, to supplement the data provided by the Montana Departments of Natural Resources and Conservation; Highways; Health and Environmental Sciences; and Fish and Game; Montana State University, Department of Agricultural Economics; and University of Montana Department of Environmental Studies.

C. REVIEW OF THE STATEMENT

In accordance with guidelines of the Council on Environmental Quality and the Montana Department of State Lands, copies of the draft statement will be made available to the public for their comments and suggestions. Comments were also solicited from the above-mentioned agencies and organizations.

The draft environmental statement is available for public review at the following places:

U.S. Geological Survey Library, 1526 Cole Blvd., Golden, CO 80401

U.S. Geological Survey Library, Room 4A100, USGS National Center, 12201 Sunrise Valley Drive, Reston, VA 22092

Montana Department of State Lands, 1625 11th Ave., Helena, MT 59601

Bureau of Land Management (West of Miles City), P.O. Box 940, Miles City, MT 59301

Parmley Billings Public Library, 510 North Broadway, Billings, MT 59103

Sheridan County Fulmer Public Library, 320 North Brooks, Sheridan, WY 82801

Big Horn County Public Library, 419 North Custer Ave., Hardin, MT 59034

The Rosebud County Library, 201 North 9th Ave., Forsyth, MT 59327

A limited number of copies are available on request from the United States Geological Survey, Land Information and Analysis Office, Box 25046, Mail Stop 701, Federal Center, Lakewood, CO 80025; and, over the counter only, from the U.S. Geological Survey Public Inquiries Office, Room 1012, Federal Building, 1961 Stout Street, Denver, CO 80202; and the Montana Department of State Lands, 1625 11th Ave., Helena, Montana 59601.

Written comments on the draft statement will be accepted for a period of 45 days subsequent to the filing with EPA and the Montana Environmental Quality Council. All substantive comments received will be considered in preparing the final environmental statement on this proposal. Written comments should be addressed to Director, United States Geological Survey, 108 National Center, Reston, VA 22092.

Comments on the draft environmental statement are sought from industry, officials from all levels of government, environmental groups, and concerned citizens. Those who wish to testify at the hearings should secure a registration form from the U.S.G.S., Northern Powder River Basin EIS office, P.O. Box 1135, 2602 First Ave. North, Room 251, Billings, MT 59103, or from the Montana Department of State Lands, Capitol Station, Helena, MT 59601. Those unable to appear at the hearings should submit written comments to: Director, U.S. Geological Survey, 108 National Center, Reston, VA 22092.

Testimony at the hearings plus the views of all concerned levels of government will be used in revising the draft statement into a final environmental impact statement.

CHAPTER X

REFERENCES

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REFERENCES

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CHAPTER XI

APPENDIXES

APPENDIXES

Appendix A.--Overburden characteristics at the Big Sky mine

a. pH

Except for near-surface sands in two drill holes (2245 and 3010) which equal the 8.8 State suspect level, all of the overburden pH values fall below State suspect levels. Three test holes in section 13 and one in section 15 (560, 565, 579, and 3010) contain interburden shales with low pH (4.1-4.3).

b. Sodium-adsorption-ratio

Three intervals of test hole 2408 contain strata which exceeded the State suspect levels for SAR.

c. Boron

Two test holes (579 and 2408) intercepted strata where the boron concentration exceeded State suspect levels.

d. Copper

One test hole (4000) contained two intervals in which the copper concentrations exceeded State levels.

e. Lead

Two drill holes (565 and 3010) contain interburden strata that approach State suspect levels. They were associated with low pH strata.

f. Zinc

Five drill holes (481, 2039, 2115, 2214, and 4000) intercepted strata where the zinc concentrations exceeded State suspect levels. The well holes are located in sections 13, 14, 15, and 22, and exhibited no areal pattern. Concentrations usually occurred in the 10-30 feet of overburden near the surface, but two wells contained multiple concentrations within 50 feet of the surface. Some of the higher zinc concentrations (those exceeding 100 ppm) occurred as follows:

[The State suspect level for zinc is 40 ppm]

Drill hole No.	Interval (ft)		Zinc (ppm)
	From	To	
481	24.3	25.2	152.2
2115	29.0	30.0	253.0
2115	30.0	40.0	124.7
2039	10.0	13.1	109.8

Appendix A.--Overburden characteristics at the Big Sky mine--Continued

g. Nitrate

Ten drill holes (152,481, 579, 1888, 2115, 2191, 2267, 2408, 3010, and 4004) contain strata in which nitrate levels exceed Federal drinking-water standards. The high nitrate zones occurred at or near the surface. One drill hole contained layers, (tabled below), which contained nitrate in excess of Federal livestock standards (50 ppm).

Drill hole No.	Interval (ft) From	To	Nitrate (ppm)
1888	10.0	11.0	57.4
1888	11.0	19.0	74.0
1888	19.0	29.0	112.0
1888	29.0	30.0	51.8

h. Soluble salts

Thirteen test holes intercepted saline layers with multiple layers found in test holes located in section 13, 14, and 15. Overburden containing excessively high concentrations of soluble salts were located in two holes as follows:

[The State suspect level for soluble salts is 4-6 mmhos/cm[1]]

Drill hole No.	Interval (ft) From	To	Electrical Conductivity (mmhos/cm)
1783	4.5	15.4	16.0
2408	0.5	2.2	19.0
2408	12.3	14.5	16.0
2408	14.5	17.4	17.0
2408	17.4	21.7	16.0

The saline concentrations were usually less than 30 feet and never more than 70 feet deep.

i. Texture

All drill holes except three (481, 2019, and 4000) intercepted one or more intervals where the clay content exceeded 40 percent. Clay layers occurred throughout the column but were most frequently found with the interburden shales or shales immediately below the coal. Some of the higher clay contents (50% or greater) were located as follows:

[1]Millimhos per centimeter, a measure of electrical conductivity.

Appendix A.--Overburden characteristics at the Big Sky mine--Continued

[The State suspect level for texture is 40-percent clay]

Drill hole No.	Interval (ft) From	To	Percent Clay	Drill hole No.	Interval (ft) From	To	Percent Clay
565	110.1	116.1	53.6	2214	21.7	29.0	57.6
565	124.5	125.7	59.6	2214	91.7	101.9	52.0
1524	105	106	51.2	2217	60.7	68.0	50.0
1783	4.5	15.4	53.6	2267	111.0	113.2	58.0
1960	125.7	127.2	55.6	2408	0.0	0.5	52.8
2115	69.2	79.4	53.2	2408	0.5	2.2	55.2
2115	94.9	95.6	56.8	3010	126.3	127.9	59.2
				3010	145.5	146.7	59.2

Where the clay content exceeded 50 percent, it was adjacent to the coal beds except in drill holes 1783 and 2408 where it was at or near the surface.

j. Cadmium

All but one drill hole contained one or more intervals that exceed the lower cadmium suspect level of 0.1 ppm, but none exceeded 1 ppm. The higher cadmium levels were found near the surface (highest level, 0.5 ppm in drill hole 152), or in strata adjacent to the coal beds.

k. Molybdenum

All overburden test holes contained one or more intervals which exceeded State suspect levels. The molybdenum content reached 172 ppm in the sandstone immediately above the Rosebud coal in drill hole 565. The highest molybdenum concentrations were associated with the strata adjacent to the coal.

l. Nickel

Nineteen drill holes contained nickel concentrations which exceeded State suspect levels. Some of the higher nickel concentrations (2.0 ppm or greater) are located as follows:

[The State suspect level for nickel is 1.0 ppm]

Drill hole No.	Interval (ft) From	To	Nickel (ppm)
560	72.2	79.0	5.1
565	110.1	116.1	5.0
579	47.5	54.0	8.2
1960	106.8	116.8	2.0
3010	90.0	3.1	2.5
3010	126.3	7.9	2.4

Appendix A.--Overburden characteristics at the Big Sky mine--Continued

Nickel concentrations were scattered throughout the overburden column below six feet and were commonly associated with intervals adjacent to the coal. The highest concentrations were from interburden samples in section 13.

Appendix B-1.--Hydrology

Lead is toxic and the recommended limits are 0.05 mg/L for human consumption and 0.10 mg/L for livestock. No water samples from the Northern Powder River Basin, either ground or surface water, have been shown by the U.S. Geological Survey to contain lead in excess of 0.10 mg/L. A number of ground water samples do, however, exceed the 0.05 mg/L recommended limit. Van Voast (1977) reported much higher concentrations of lead; however, he acknowledged (p. 36) the possibility that the higher concentrations may be due to differences in analytical methods.

The recommended limit for lead and a discussion of the uncertainties as to what this limit should be are given on page 70 of "Water quality criteria 1972" EPA. R3-73.033 March 1973. Based on the discussion that precedes the recommendation it would appear unlikely that lead concentrations in the range 0.05 to 0.10 mg/L would be toxic unless the total ingestion of lead from other sources was unusually high.

The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	Level, milligrams per liter
Arsenic	0.05
Barium	1.00
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

When the annual average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature degrees Fahrenheit	Degrees Celsius	Level, milligrams per liter
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

Appendix B-2.--Sediment yield

Estimates of the natural sediment yield were derived from an empirical relationship between mean annual sediment accumulation and relief ratio (fig. 1). The relationship is based upon data collected from watersheds in the Upper Cheyenne River Basin in Wyoming. These basins are on the Fort Union Formation in a region that receives approximately 13 inches of annual precipitation, and, therefore, is similar to the Big Sky mine site.

Estimates of the sediment yield for subbasins within the Big Sky mine site were obtained as follows:

1. The relief ratio for each subbasin was calculated from information obtained from USGS topographic maps. Relief ratio was obtained by dividing the difference in elevation between the mouth of a small watershed and its headwater divide, by the length of the basin. The length of the basin was measured essentially parallel to the main drainage channel within the basin, and may not be the maximum basin length.

2. Using the calculated relief ratio, a value of sediment yield (equal to sediment accumulation) was obtained from figure 1.

3. Sediment yield in acre-ft/mi^2/year was converted to sediment yield in tons/year.

The sediment yield for each individual subbasin is presented in table 1. Estimated sediment yields ranged from 0.29 to 4.00 acre-ft/mi^2/year. Sediment yield is inversely proportional to basin area, the highest estimated yields are for small headwater tributaries at the base of the cliff. The permit area as a whole has a weighted mean average sediment yield of 0.93 acre-ft/mi^2/year. For several incomplete basins (A, F', and I), sediment yields were not estimated, but this should not greatly alter the results.

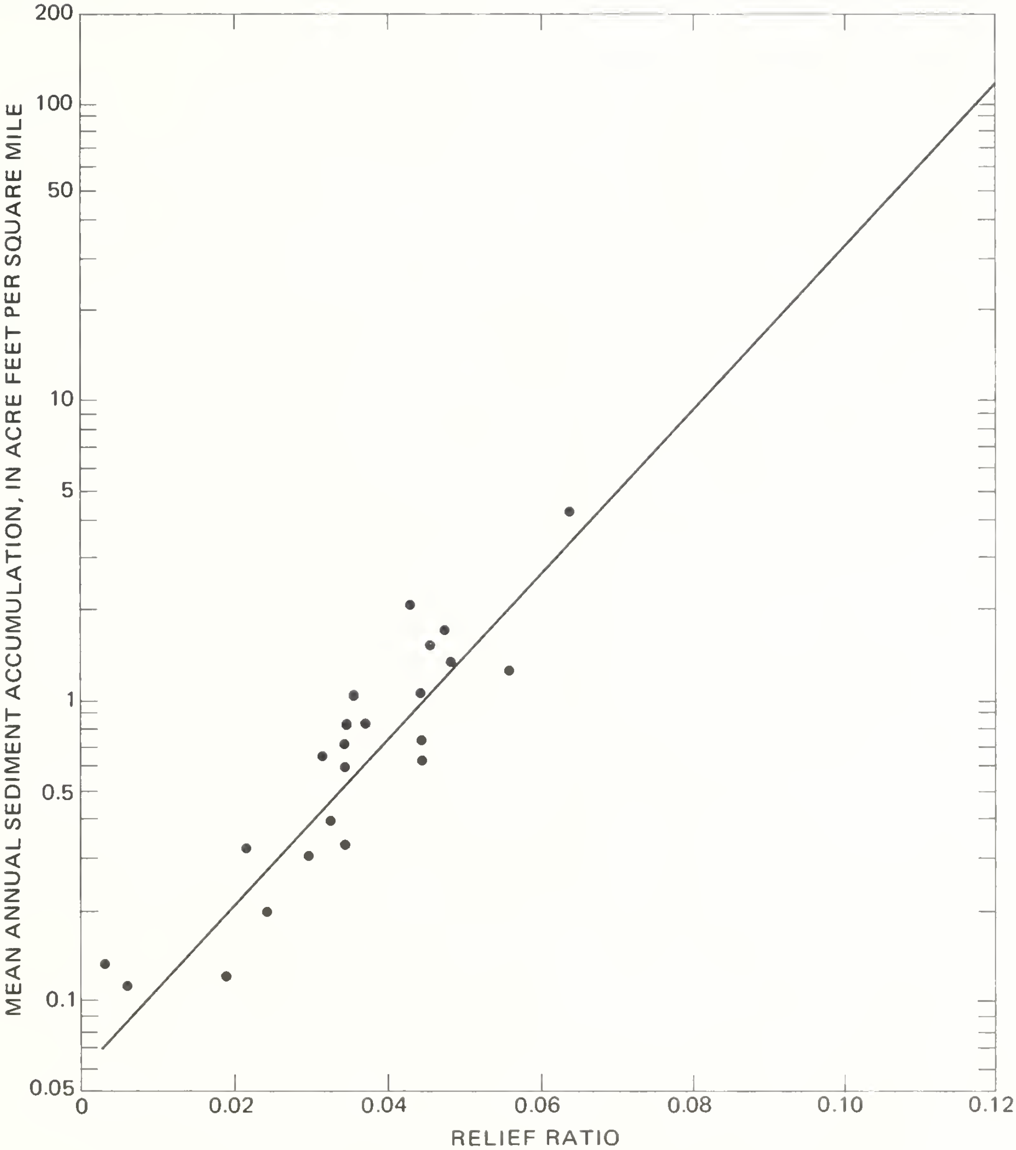

Figure 1.—Relation between mean annual sediment accumulation and relief ratio for basins on the Fort Union Formation (Hadley and Schumm, 1961, figure 31).

TABLE XI-1.--Estimated rates of natural sediment yield

Sub-basin	Area (acres)	Length (ft)	Relief (ft)	Relief ratio	Yield	
					Acre-ft/mi^2/yr	Tons/yr
A	---	---	---	---	---	---
B	378	[1]9,500	370	0.039	0.70	720
C	224	5,550	245	0.044	0.95	579
D	205	6,500	270	0.042	0.80	446
E	256	6,400	420	0.066	3.90	2,718
F	249	5,650	382	0.068	4.00	2,712
F'	---	---	---	---	---	---
G	563	7,950	372	0.047	1.20	1,839
H	2,013	17,500	440	0.025	0.29	1,589
I	---	---	---	---	---	---
J	755	10,800	[2]370	0.034	0.55	1,131

[1]Basin length measured in two segments.

[2]Relief adjusted downward, headwaters ended at anomalously high point.

Appendix C-1.--Historical averages of total precipitation (inches) by months and years for selected time periods at Colstrip

Time period	Monthly averages						
	Jan.	Feb.	Mar.	Apr.	May	June	July
1941-50---	9.09	0.58	1.24	1.10	2.26	2.54	1.58
1951-60---	0.38	0.61	0.68	1.68	2.52	2.65	1.01
1961-70---	0.75	0.65	0.68	2.36	2.42	3.20	1.23
1971- ---		0.65	0.55	1.74	2.54	2.93	0.86
1941-70---	0.56	0.56	0.74	1.86	2.47	3.31	1.18

	Monthly averages--Con.					Annual averages (year)
	Aug.	Sept.	Oct.	Nov.	Dec.	
1941-50---	0.48	1.33	0.71	0.65	0.41	13.65
1951-60---	1.69	.73	1.16	0.72	0.53	14.36
1961-70---	1.22	1.67	.75	.69	0.82	16.45
1971-76---	1.46	0.59	3.23	0.32	0.65	17.94
1941-70---	1.39	1.38	1.04	0.61	0.63	15.79

Appendix C-2.--Probability of specified freezing temperatures occurring after given date in spring or before given date in fall

[Source: U.S. Dept. of Commerce, NOAA Climatography of U.S. No 20-24]

Temp (°F)	Spring			
	75%	50%	25%	10%
32-----	May 16	May 24	June 1	June 8
28-----	May 3	May 11	May 19	May 28
24-----	Apr. 22	Apr. 30	May 8	May 15
20-----	Apr. 12	Apr. 20	Apr. 28	May 5
16-----	Apr. 4	Apr. 12	Apr. 20	Apr. 27

Temp (°F)	Fall			
	10%	25%	50%	75%
32-----	Sept. 1	Sept. 9	Sept. 18	Sept. 27
28-----	Sept. 13	Sept. 21	Sept. 30	Oct. 9
24-----	Sept. 23	Oct. 1	Oct. 10	Oct. 19
20-----	Oct. 1	Oct. 9	Oct. 18	Oct. 27
16-----	Oct. 15	Oct. 23	Nov. 1	Nov. 10

Appendix D-1.--Maximum theoretical particulate emissions - Peabody Coal Company, Big Sky mine coal production rate = 2.3 x 10^6 tons/year

Equipment and materials	Activity	Number of units	Extent of activity/year/unit	Emission factor/year	Source	Maximum 1977 emissions (T/yr)
14 yd^3 Marion 7400 dragline	Overburden excavation	1	1,280,000 tons	0.05 lb/ton	1	28.2
30 yd^3 Marion 7800 dragline	Overburden excavation	1	7,096,000 tons	0.05 lb/ton	1	177.4
B-E 50R overburden drill	Overburden drilling	1	8,137 holes	0.22 lb/hole	2	0.9
D-9 Cat dozer	Clean pit - push spoil	2	3,120 hours	32.0 lb/hour	3	100.0
D-8 Cat dozer	Clean pit - push spoil	3	3,120 hours	32.0 lb/hour		150.0
Wabco scraper	Topsoil handling	2	2,971 hours	32.0 lb/hour		95.2
988 front end loader	Clean pit - load coal	1	1,780 hours	32.0 lb/hour		28.5
475 front end loader	Clean pit - load coal	1	1,780 hours	32.0 lb/hour		28.5
B-E 30R coal drill	Coal drilling	2	5,101 holes	2.25 lb/hole	2	11.5
Marion 191 coal loader	Coal loading	1	1,260,000 tons	0.05 lb/ton	1	31.5
Coal haul trucks (70 tons)	Coal hauling	6	16,027 mi	3.5 lb/mi	4	168.3
14-G motor grader	Grade roads	1	1,780 hours	32.0 lb/hour	3	28.5
Lube truck	Equipment servicing	1	1,200 mi	0.9 lb/mi	3	0.5
Powder truck	Haul explosives	1	1,105 mi	0.9 lb/mi		0.5
Blasting	Coal and overburden	---	260 blasts	77 lb/blast	2	10.0
Diesel fuel	Combustion	---	175,059 gal	27.3 lb/10^3 gal	5	2.4
Gasoline	Combustion	---	42,209 gal	12 lb/10^3 gal	5	0.3
Locomotive, diesel fuel	Combustion	230 trains	4 mi	1.07 lb/mi	6	0.5
Employee vehicles	Mine entrance	42 cars	1,240 mi	0.9 lb/mi	3	23.4
Outdoor coal storage	Wind erosion	---	2.3 x 10^6 tons	1.7 lb/ton	7	1,774.0
Coal crusher	Crushing & screening	---	2.3 x 10^6 tons	2.0 lb/ton	8	2,087.0
Coal conveying	Conveying	---	2.3 x 10^6 tons	1.0 lb/ton	8	1,043.5
Surface disturbed	Wind erosion	---	360 acres	0.54 ton/acre	1	194.4

Total 1977 particulate emissions = 5,985.0

Regional particulate sources	Number of units	Extent of activity	Emission factor/year	Source	1977 Emissions (tons/year)
Population effect on Forsyth		109 people	0.6 tons/person	9	6.5
Employee transportation					
Forsyth to Big Sky	14 cars	20,832 mi	0.0012 lb/mi	10	0.2
Rural area to Big Sky	20 cars	248,000 mi	0.0012 lb/mi		3.0
Colstrip to Big Sky	3 cars	2,406	0.0012 lb/mi		-
Locomotive fuel combustion	230 trains	82 mi	1.07 lb/mi	7	10.1
Coal dust loss, unit-trains	230 trains	10,000 tons	0.001 tons/ton	11	2,300.0

Total 1977 particulate emissions = 2,319.8

[1]PEDCo - Environmental, Inc., Southeastern Montana Coal Resource, AQMA Analysis. U.S. EPA, Region VIII, Air Planning and Operations Section, Denver, Colo. March 1977, 52 pp.

[2]U.S. EPA, Survey of Fugitive Dust from Coal Mines. Region VIII, Denver, Colo., 80295, February, 1978. 115 pp.

[3]Draft EIS, Eastern Powder River Coal Basin of Wyoming: 1974. Prepared by Dept. of Agriculture, Interstate Commerce Commission, Dept. of the Interior, 1974, Appendix B-p 1-7.

[4]PEDCo Environmental, 1973, in Final Northwest Colorado Coal Final EIS: Dept. of the Interior, Appendix D, p. VI-24.

[5]U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Report AP-42, February 1976, Tables 3.2.7-1 and D.4-15. pp. 3.2.7-1 and D.4-9.

[6]URS, Coal Train Assessment., Final Report: December 15, 1976. page V-16.

[7]Cowherd Jr., Chatten, J. H. Southerland and C. O. Mann. Development of Emission Factors for Fugitiver Dust Sources: MRI and EPA. p. 27.

[8]U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Report No. AP-42, February 1976, Table 8.20-1. p. 8.20-1.

[9]NAMP Air Quality and Emission Trends Annual Report: Vol. 2. August 1973: EPA 450/1-73-001.

[10]U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Repor No. AP-42, Part B. February 1976, Table D.1-9, based on 1975 test procedure, p. D.1-6.

[11]Paulson, L. E., S. A. Cooley, C. Wegert, and R. C. Ellman, 1976, Experiences in transportation of dried low-ran

Appendix D-2.--Current dust control techniques, percent dust reduction, and resultant decrease in potential particulate emissions

[Example: 1977 particulate emissions]

	Source	Potential emissions (tons/yr)	Mitigation	Percent efficiency of mitigation	Controlled emissions (tons/year)	Percent emission control
Haul roads	Haul trucks	168.3	Water spray[1]	50	(0.5)(168.3) + 28.5 (road grader) = 112.7	(196.8 - 112.7)/ 196.8 = 42.7
	Road grader	28.5	---			
Coal handling	a) Conveyors	1,043.5	Water spray[2]	---	a) (0.8)(1,043.5) = 834.8 1,043 - 834.8 = 208.7	
			Hooded conveyor	80 est.		
	b) Crushers & screeners(2)	1,043.5, each	Enclosed grizzly[2]	80 (settles out)	b) (1,043.5)(0.8) = 834.8 1,043.5 - 834.8 = 208.7	
					Total: 208.7 + 1,251.7 = 1,460.4	(3,130.5 - 626.1) 3,130.5 x 100 = 53.3
Wind erosion	Surface area	194.4			(0.8)(1,774.0) = 1,419.2	
	Coal pile	1,774.0	Storage barn[2]	80 (settles out)	1,774.0 - 1,419.2 = 354.8 + 194.4 = 549.2	(1,968.4 - 549.2) 1,968.4 x 100 = 72.1
Mine entrance road	Road dust	23.4	Chemical[3] (Coherex)	88	(0.88)(23.4) = 20.6 23.4 - 20.6 = 2.8	
			Water spray[1]	50	(0.5)(2.8) = 1.4	(23.4 - 1.4 23.4 x 100 = 94

[1]Richard and Safriet, 1977.
[2]U.S. Environmental Protection Agency, 1976.
[3]U.S. Environmental Protection Agency, 1977.

Appendix D-3.--Maximum theoretical particulate emissions - Peabody Coal Company, Big Sky mine coal production rate = 4.2×10^6 tons/year

Equipment & materials	Type of activity	No. of vehicles or material units	Extent of activity/year/unit	Emission factor/unit	Source	Maximum 1985 emissions(T/yr)
14 yd^3 Marion 7400 dragline	Overburden excavation	1	2,306,535 tons	.05 lb/ton	1	57.7
30 yd^3 Marion 7800 dragline	Overburden excavation	1	12,109,311 tons	.05 lb/ton		302.7
B-E 50R overburden drill	Overburden drilling	1	15,716 holes	.22 lb/hole	2	1.7
D-9 Cat dozer	Clean pit - push spoil	2	4680 hours	32.0 lb/hr	3	149.8
D-8 Cat dozer	Clean pit - push spoil	3	4680 hours	32.0 lb/hr		224.6
Wabco scraper	Topsoil handling	2	2971 hours	32.0 lb/hr		95.1
988 front end loader	Clean pit - load coal	1	1780 hours	32.0 lb/hr		28.5
475 front end loader	Clean pit - load coal	1	1780 hours	32.0 lb/hr		28.5
B-E 30R coal drill	Coal drilling	2	11,216 holes	2.25 lb/hole	2	25.2
Marion 191 coal loader	Coal loading	1	3,000,000 tons	0.05 lb/ton	1	75.0
Coal haul trucks (70 tons)	Coal hauling	6	95,600 mi	3.5 lb/mi	4	1,003.8
14-G motor grader	Grade roads	1	1780 hours	32.0 lb/hr	3	28.5
Lube truck	Equipment servicing	1	1098 mi	0.9 lb/mi	3	0.8
Powder truck	Haul explosives	1	1014 mi	0.9 lb/mi		0.7
Pickup truck						
Blasting	Coal and overburden	---	475 blasts	77.0 lb/blast	2	18.3
Diesel fuel	Fuel	---	257,757 gal	27.3 lb/10^3 gal	5	3.5
Gasoline	Fuel	---	23,208 gal	12.0 lb/10^3 gal	5	.1
Locomotive, diesel fuel	Fuel combustion	420 trains	5 mi	1.07 lb/mi	6	1.1
Employee vehicles	Mine entrance	49 cars	1240 mi	0.9 lb/mi	3	27.3
Outdoor coal storage	Wind erosion	---	4.2×10^6 tons	1.7 lb/ton	7	3,570.0
Coal crusher	Crushing & screening	---	4.2×10^6 tons	2.0 lb/ton	8	4,200.0
Coal conveying	Conveying	---	4.2×10^6 tons	1.0 lb/ton	8	2,100.0
Surface disturbed	Wind erosion	---	454 acres	.54 T/acre	1	245.2
			Total 1985 particulate emissions =			12,188.1

Regional particulate sources			Emission factor/year		1985 Emissions (tons/year)
Population effect on Forsyth		239 people	0.06 tons/person	9	24.5
Employee transportation		49 cars, total	0.0005 lb/mi	10	0.1
Locomotive fuel combustion	420 trains	82 mi	1.07 lb/mi	7	18.4
Coal dust loss, unit-trains	420 trains	10,000 T/train	.001 tons/ton	11	4,200.0
		Total 1985 particulate emissions =			4,243.0

[1] PEDCo - Environmental, Inc., Southeastern Montana Coal Resource, AQMA Analysis: U.S. EPA, Region VIII, Air Planning and Operations Section, Denver, Colo. March 1977, 52 pp.

[2] U.S. EPA, Survey of Fugitive Dust from Coal Mines: Region VIII, Denver, Colo., 80295, February, 1978. 115 pp.

[3] Draft EIS, Eastern Powder River Coal Basin of Wyoming: 1974. Prepared by Dept. of Agriculture, Interstate Commerce Commission, Dept. of the Interior, 1974, Appendix B-p 1-7.

[4] PEDCo Environmental, 1973, in Final Northwest Colorado Coal Final EIS: Dept. of the Interior, Appendix D, p. VI-24.

[5] U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Report AP-42, February 1976, Tables 3.2.7-1 and D.4-15. pp. 3.2.7-1 and D.4-9.

[6] URS, Coal Train Assessment, Final Report: December 15, 1976. page V-16.

[7] Cowherd Jr., Chatten, J. H. Southerland and C. O. Mann. Development of Emission Factors for Fugitive Dust Sources: MRI and EPA. p. 27.

[8] U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Report No. AP-42, February 1976, Table 8.20-1. p. 8.20-1.

[9] NAMP Air Quality and Emission Trends Annual Report: Vol. 2. August 1973. EPA 450/1-73-001.

[10] U.S. EPA, 1976, Compilation of Air Pollutant Emission Factors for Fugitive Dust Sources, Second Edition: Repor No. AP-42, Part B. February 1976, Table D.1-21, based on 1975 test procedure, p. D.1-12.

[11] Paulson, L. E., S. A. Cooley, C. Wegert, and R. C. Ellman, 1976, Experiences in transportation of dried low-ran Western Coals: Society of Mining Engineers, A.I.M.E., Transactions 260:300-305.

Appendix D-4.--Proposed dust control techniques and the percent reduction in potential particulate emissions from the Big Sky mine during years of 4.2 x 10^6 tons coal production

Emission source	Potential emissions (tons/yr)	Present dust control techniques	Dust control efficiency (tons/yr)	Actual emissions (tons/yr)
		Permit area		
Overburden excavation----	841.7	None	---	841.7
Coal extraction----	166.9	None	---	166.9
Coal hauling-------	1,032.3	Watering haul roads	48.6	530.4
Coal handling------	6,300	Watering transfer points hooded conveyors	53.3	2,940.0
Wind erosion---	3,815.2	Coal storage barn	74.8	959.2
Fuel combustion----	4.7	None	---	4.7
Employee transport-----	27.3	Chemical and water suppression	93.7	1.7
Permit area totals---	12,188.1	Approximately	55.3	5,444.6
		Regional sources		
Employee transport-----	0.1	---	---	0.1
Locomotive fuel combustion-----	18.4	---	---	18.4
Coal dust loss, unit-trains---	4,200.0	---	---	4,200.0
Population effect, Forsyth-------	24.5	---	---	24.5
Total regional sources---	4,243.0	---	---	4,243.0

Appendix D-5.--Estimated gaseous emissions related to the Big Sky mine

[Emission values are in tons per year. Strip-mine-related emissions are based on a coal extraction rate of 4.2 million tons per year]

Source	Number of units/year	CO	NO_x	SO_x	HC	HCN	Aldehydes	Organic acids	All pollutants
Blasting:									
Explosives---------	988.5 tons	1.6	21.1	([a])	([a])	0.05	([a])	([a])	22.75
Diesel fuel:									
Heavy duty equipment--------	257,757 gal	12.7	54.0	4.0	5.4	([a])	1.2	([a])	77.3
Gasoline:									
Heavy duty truck---	117,000 mi	15.6	1.6	0.05	0.8	([a])	([a])	([a])	18.05
Total permit area sources--------------		29.9	76.7	4.05	6.2	0.05	1.2	([a])	118.1
Gasoline:									
Light duty trucks:	10 trucks								
Forsyth to Big Sky------------	208,320 mi	2.2	0.3	0.04	0.2	([a])	([a])	([a])	2.74
Employee vehicles:									
Forsyth to Big Sky------------	187,488 mi	0.5	0.05	0.03	0.05	([a])	([a])	([a])	0.63
Colstrip to Big Sky------------	20,460 mi	0.06	0.01	---	0.01	([a])	([a])	([a])	0.08
Rural to Big Sky-	372,000 mi	1.1	0.09	0.06	0.09	([a])	([a])	([a])	1.34
Coal trains:	420 trains								
Forsyth to Big Sky-	37,170 mi	104.1 [b](2.3)	295.5 (6.6)	45.5 (1.1)	75.0 (1.8)	([a]) ([a])	4.5 (0.1)	5.6 (0.13)	530.2
Forsyth:									
Population effect--	239 people	81.3	40.6	16.7	31.1	([a])	([a])	([a])	169.7
Total regional sources------------------		189.26	336.55	62.33	106.45	([a])	4.5	5.6	704.69

[a]Emission factors unknown.
[b]Tons per mile travelled per year.

Appendix D-6.--Potential human health effects

The following is an edited version originally prepared by Dr. Dale Bergren (Cardiovascular Research Institute, San Francisco, CA).

The inhalation of sufficient amounts of any dust over a prolonged period of time will produce some type of disease, either irritative or chemical (Wolf, F. A., 1975). Specifically, exposure to dust during the mining of coal may lead to one of three pulmonary disorders: coal miners' pneumoconiosis, silicosis or industrial bronchitis. The conditions of pneumoconiosis and silicosis and also silicosis and bronchitis are known to co-exist (Morgan, W. K. C., and N. L. Lapp, 1976). Of the three respiratory disorders, silicosis is the most common and most serious. It is caused by the inhalation of airborne silicates having diameters from 0.6 micrometers (u) to 5.0 micrometers, the "respirable fraction". These particulates have the potential of reaching the gas exchange regions of the lungs: the respiratory ducts, the antrum and the alveoli. At this point, sedimentation in the fluid lining can occur (Mayer, M. R., 1969).

The dangers of silicosis increase when the dust is freshly generated and when the particle size is extremely small. This occurs in the case of dust generated by blasting and drilling overburden since 10 percent of the earth's crust is quartz (SiO_2). Other factors which influence the danger of silicosis are the combination with other particulate, duration of contact, worker's age and past history of respiratory function. Smoking has been shown to increase the rate of silicosis in miners thirty times (Cralley, L. V., L. J. Cralley, G. D. Clayton and J. A. Jurgiel, 1972).

Coal miner's pneumoconiosis, best known as black lung, is the result of inhaled coal dust high in silicon (Wolf, F. A., 1975). The dust becomes deposited around the bronchioles and arterioles causing "focal emphysema." Usually there is not much fibrotic tissue formation. However, massive fibrosis may form due to secondary infection of tuberculosis. If fibrosis occurs, symptoms are likely to progress despite transfer to a clean environment.

Mining Operations and the Surrounding Community

The effect of mining upon respiratory function is not always limited to the employed population, but has been shown to be reflected in the general population.

In a study of a metal mining community (where open-pit mining is the prevalent form) and a smelting community, it was observed that the incidence of lung carcinoma not only was elevated in the mining and smelting workers, but also among women who did not experience occupational exposure when compared to the rates in other cities (Newman, J. J. A., Archer, V. E., Saccomanno, G., and others, 1976).

Although the toxic substance was not identified, the best explanation for this situation seems to be that the same agent which increased cancer among the men from occupational exposure also increased the cancer among the women. In the smelting city, air-borne arsenic, sulfur dioxide, and possibly nitrogen dioxide may be indicated as the causal factors.

In a separate study, several communities, where underground coal mines are a prominent industry provided statistics showing silicosis and black lung were clearly occupationally related (Enterline, P., 1967). Unexpectedly, however, the wives of the miners' reported more respiratory disorders than the wives of other workers. It stated, "If occupational factors are involved in any way in the reported cough, phleym, wheezing, and breathlessness; coal miner's wives seem to be nearly as effected by their husbands' occupation as husbands themselves." A possible explanation offered by the author is that chronic bronchitis contracted by the miners as a result of exposure to coal dust may have an infectious aspect in the bacteriological sense.

Appendix E.--Soil capability groups, defined

The Soil Conservation Service has developed a system of capability groupings which show, in a general way, the suitability of soils for agricultural uses.

Capability groups III, IV, VI, VII, and VIII are mapped in the Big Sky permit area. These are defined as follows:

Class III: These soils have severe limitations that reduce the choice of crops or require special conservation practices, or both.

Class IV: Similar to Class III soils, but with very severe limitations and/or requiring very careful management.

Class VI: These soils have severel limitations making them generally unsuited to cultivation and limit their use largely to pasture, range or wildlife habitat.

Class VII: Similar to Class VI, with even more severe limitations.

Class VIII: These soils and land forms have limitations that preclude their use for crops or rangeland and restrict their use to recreation, wildlife habitat, watershed or esthetic purposes.

Within the various capability classes, subclasses are designated by adding a small letter c, e, s, or w to the Roman numeral; for example, IVe. Within the permit area, only subclass "e" is represented, indicating that the main limitation is risk of erosion unless close-growing plant cover is maintained. Erosion risk is a function of soil texture, and the frequently high intensity precipitation characteristics of the area. The subclass "s" indicates that the main limitation is the shallowness of the soils, and that thay are droughty and stony in nature.

Appendix F-1.--Plants in the Big Sky permit area

Common name	Scientific name
Forbs	
Alfalfa-------------------	Medicago sativa
American vetch------------	Vicia americana
Annual eriogonum----------	Eriogonum annum
Aster---------------------	Aster oblongifolius
Bessey pointvetch---------	Oxytropis besseyi
Big sagebrush-------------	Artemisia tridentata
Blue flax-----------------	Linum perenne
Blue lettuce--------------	Lactuca pulchella
Broom snakeweed-----------	Gutierrezia sarothrae
Cicer milkvetch-----------	Astragalus cicer
Clover--------------------	Trifolium spp.
Common dandelion----------	Taraxacum officinale
Common salsify------------	Targopogon dubius
Common sowthistle---------	Sonchus oleraceus
Cudweed sagewort----------	Artemisia ludoviciana
False-tarragon sagewort---	Artemisia dracunculus
Field chickweed-----------	Cerastium arvense
Fleabane------------------	Erigeron pumilus
Fringed sagewort----------	Artemisia frigida
Golden-aster--------------	Chrysopsis villosa
Hoods phlox---------------	Phlox hoodii
Littlepod false-flax------	Camelina microcarpa
Low ragweed---------------	Ambrosia artemisifolia
Lupine--------------------	Lupinus spp.
Mariposa lily-------------	Calochortus nuttallii
Meadow death camas--------	Zigadenus venenosus
Milkvetch-----------------	Astragalus gracilis
Milkweed------------------	Asclepias verticillata
Mountain star lily--------	Leucocrinum montanum
Narrow-leaved collomia----	Collomia linearis
(None)--------------------	Allium spp.
Nuttall sunflower---------	Helianthus nuttallii
Phacelia------------------	Phacelia spp.
Pinnate tansy mustard-----	Descurainia pinnata
Plains prickleypear-------	Opuntia polyacantha
Plains wallflower---------	Erysimum asperum
Prairie clover------------	Petalostemon spp.

Appendix F-1.--Plants in the Big Sky permit area--Continued

Common name	Scientific name
Forbs--Continued	
Prairie coneflower	Ratibida columnifera
Purple prairie-clover	Petalostemon purpureus
Rose pussytoes	Antennaria rosea
Rush skeleton weed	Lygodesmia juncea
Russian thistle	Salsola kali
Scarlet gaura	Gaura coccinea
Scarlet globemallow	Sphaeralcea coccinea
Shrubby evening primrose	Oenothera serrulata
Silverleaf scurfpea	Psoralea argophylla
Silver sagebrush	Artemisia cana
Skunkbush sumac	Rhus trilobata
Soapweed	Yucca glauca
Spindle plantain	Plantago spinulosa
Stiffstem flax	Linum rigidum
Wavyleaf thistle	Cirsium undulatum
White sweetclover	Melilotus alba
Wood's rose	Rosa woodsii
Woolly plantain	Plantago purshii
Yarrow	Achillea millefolium
Yellow sweetclover	Melilotus officinalis
Yellow owl clover	Orthocarpus luteus
Grasses and grasslike plants	
Big bluestem	Andropogon gerardii
Blue grama	Bouteloua gracilis
Bluebunch wheatgrass	Agropyron spicatum
Crested wheatgrass	Agropyron cristatum
Downy chess brome	Bromus tectorum
Green needlegrass	Stipa viridula
Indian ricegrass	Oryzopsis hymenoides
Intermediate wheatgrass	Agropyron intermedium
Japanese chess	Bromus japonicus
Junegrass	Koeleria cristata
Kentucky bluegrass	Poa pratensis

Appendix F-1.--Plants in the Big Sky permit area--Continued

Common name	Scientific name
Grasses and grasslike plants--Continued	
Little bluestem-----------	Andropogon scoparius
Needle-and-thread---------	Stipa comata
(None)--------------------	Carex pennsylvanica
Prairie sand reedgrass----	Calamovilfa longifolia
Red three-awn-------------	Aristida longiseta
Sandberg bluegrass--------	Poa secunda
Side-oats grama-----------	Bouteloua curtipendula
Smooth brome--------------	Bromus inermis
Threadleaf sedge----------	Carex filifolia
Western wheatgrass--------	Agropyron smithii

Appendix F-2.--Canopy coverage and frequency

TABLE XI-2.--Percent canopy coverage and frequency of low-growing taxa in five natural communities within the 1976 mining permit area

Taxa	Plant community transect code				
	[1]111.2-P	111.3-P	111.4-P	212.1-P	212.2-P
Grasses and grasslike plants:					
Agropyron smithii	[2]1/15	6/15	---	9/70	14/100
Andropogon gerardi	---	3/10	4/10	---	---
Andropogon scoparius	---	---	4/10	---	---
Aristida longiseta	5/25	---	----	---	1/5
Bromus japonicus	4/45	4/40	3/65	9/50	9/85
Bromus tectorum	1/20	11/80	5/60	1/20	1/25
Calamovilfa longifolia	---	---	7/65	---	---
Carax filifolia	---	5/40	2/15	---	---
Carex pennsylvanica	---	1/5	17/45	---	---
Koeleria cristata	4/40	9/45	8/55	---	[3]Tr/10
Poa pratensis	---	---	---	14/55	---
Poa secunda	37/85	2/20	2/10	---	14/85
Stipa comata	3/25	8/45	Tr/5	---	---
Stipa viridula	1/5	---	---	3/20	---
Total	55/100	37/100	37/100	35/100	31/95
Forbs:					
Achillea millefolium	---	---	---	15/75	---
Ambrosia artemisifolia	---	---	---	4/25	---
Antennaria rosea	Tr/5	---	---	---	---
Artemisia dracunculus	---	2/20	Tr/5	---	---
Artemisia frigida	2/30	3/30	Tr/5	1/5	2/40
Asclepias verticillata	---	---	Tr/5	---	---
Aster oblongifolius	3/30	---	---	---	---
Calochortus nuttalli	---	Tr/10	Tr/5	---	---
Descurainia pinnata	---	---	Tr/5	---	---
Gaura coccinea	Tr/5	1/5	---	---	---
Lactuca pulchella	---	---	4/60	---	---
Lupinus spp.	1/15	---	---	---	---
Lygodesmia juncea	2/10	---	---	---	---
Opuntia polyacantha	---	Tr/5	---	---	---
Phlox hoodii	---	---	1/10	---	1/5
Plantago purshii	---	---	---	---	Tr/5
Psoralea argophylla	---	5/30	3/25	---	4/25
Sonchus oleraceus	---	---	---	1/5	---
Sphaeralcea coccinea	1/20	3/50	---	1/5	Tr/10

TABLE XI-2.--Percent canopy coverage and frequency of low-growing taxa in five natural communities within the 1976 mining permit area--Continued

Taxa	Plant community-transect code				
	111.2-P	111.3-P	111.4-P	212.1-P	212.2-P
Forbs--Continued					
Taraxacum officinale-------	---	---	---	36/90	3/30
Tragopogon dubius-----------	1/15	4/65	Tr/10	1/5	Tr/10
Trifolium spp.--------------	---	---	---	6/30	---
Yucca glauca----------------	---	4/5	6/20	---	---
Unknown forbs---------------	---	1/30	Tr/15	---	---
Unknown legumes-------------	---	---	Tr/10	2/15	---
Total----------------	10/85	17/95	13/85	57/100	7/70
Shrubs:					
Artemisia cana--------------	2/10	---	---	23/55	8/50
Gutierrezia sarothrae-------	2/20	---	---	---	2/10
Rosa woodsii----------------	---	---	---	1/5	---
Total----------------	3/20	---	---	27/55	8/55
Ground characteristics:					
Bare ground-----------------	21/95	24/100	10/80	17/90	34/95
Selaginella densa-----------	---	---	Tr/5	---	---
Lichens---------------------	---	3/65	Tr/5	---	1/30
Standing litter-------------	2/15	14/95	16/100	3/10	---
Down litter-----------------	18/100	27/95	29/100	18/100	15/100

[1]Plant community-transect code numbers are as follows:

111.2-- Grassland: *Poa secunda*/*Koeleria cristata*/*Stipa comata*

111.3-- Grassland: *Agropyron smithii*/*Koeleria cristata*/*Stipa comata*

111.4-- Grassland: *Calamovilfa longifolia*/*Andropogon scoparius*/*Andropogon gerardii*

211-- Big sagebrush/grassland: *Artemisia tridentata*/*Agropyron smithii*/*Koeleria cristata*

212.1-- Silver sagebrush-coulee: *Artemisia cana*/*Agropyron smithii*/*Poa pratensis*

212.2-- Silver sagebrush-bench: *Artemisia cana*/*Agropyron smithii*/*Koeleria cristata*

213-- Skunkbush/grassland: *Rhus trilobata*/*Agropyron spicatum*/*Carex filifolia*

351-- Ponderosa pine/skunkbush: *Pinus ponderosa*/*Rhus trilobata*/*Agropyron spicatum*

[2]Average percent canopy coverage/frequency among plots in each transect.

[3]Tr = Trace; a value less than 0.5 percent.

TABLE XI-3.-- Percent canopy coverage and frequency of low-growing taxa in eight natural plant communities within the mine control area

Taxa	Plant community transect code							
	[1]111.2-C	111.3-C	111.4-C	211-C	212.1-C	212.2-C	213-C	351-C
Grasses and grasslike plants:								
Agropyron smithii------	[2]5/60	11/80	2/20	25/100	11/75	16/100	---	---
Agropyron spicatum-----	---	---	---	6/100	---	---	19/85	11/85
Andropogon gerardii----	---	---	2/5	---	---	---	---	---
Andropogon scoparius---	---	---	21/55	---	---	---	---	---
Aristida longiseta-----	2/10	5/25	---	---	---	2/5	---	---
Bouteloua curtipendula-	---	---	---	---	---	---	---	1/20
Bouteloua gracilis-----	---	---	---	[3]Tr/5	---	---	---	---
Bromus japonicus-------	2/20	21/95	1/30	10/85	6/50	16/90	11/95	Tr/10
Bromus tectorum--------	1/15	4/35	---	Tr/15	26/100	---	3/55	2/35
Calamovilfa longifolia-	---	---	11/60	---	---	---	---	---
Carex filifolia--------	4/35	22/85	13/80	---	---	---	7/40	---
Koeleria cristata------	26/100	7/40	9/50	8/50	---	12/60	2/10	---
Oryzopsis hymenoides---	---	---	---	---	1/5	---	---	---
Poa pratensis----------	---	---	---	---	2/15	---	---	---
Poa secunda------------	2/10	1/15	2/15	4/10	---	1/5	3/30	---
Stipa comata-----------	8/40	6/30	8/30	15/10	13/45	---	2/20	---
Stipa viridula---------	---	---	---	6/30	2/10	6/30	---	---
Total------------	44/100	58/100	52/100	56/100	56/100	54/100	62/100	11/95
Forbs:								
Achillea millefolium---	---	---	---	---	---	5/20	---	---
Allium spp.------------	---	---	---	---	---	---	---	Tr/10
Ambrosia artemisifolia-	---	3/30	---	---	1/5	1/5	---	1/10
Antennaria rosea-------	1/5	---	---	---	---	---	---	---
Artemisia dracunculus--	---	---	4/30	---	---	---	4/4-	---

TABLE XI-3.--Percent canopy coverage and frequency of low-growing taxa in eight natural plant communities within the mine control area--Continued

Taxa	Plant community transect code							
	111.2-C	111.3-C	111.4-C	211-C	212.1-C	212-C	213-C	351-C
Forbs--Continued								
Artemisia frigida	4/40	7/80	---	---	2/5	1/5	4/40	---
Artemisia ludoviciana	---	---	---	---	---	---	---	1/5
Aster oblongifolius	---	---	---	---	---	---	---	Tr/10
Astragalus gracilis	---	---	3/25	---	---	---	---	---
Calochortus nuttalli	---	---	---	Tr/5	---	---	---	---
Camelina microcarpa	---	---	---	---	Tr/5	---	---	---
Cerastium arvense	---	---	---	1/5	---	---	---	---
Chrysopsis villosa	---	---	Tr/10	---	---	---	---	---
Cirsium undulatum	---	---	---	---	---	---	---	Tr/5
Collomia linearis	---	---	---	---	---	---	1/10	2/30
Compositae	---	---	---	---	---	---	Tr/5	---
Erigeron pumilus	---	---	---	Tr/5	---	---	---	---
Eriogonum annum	---	---	1/5	---	---	---	--	---
Erysimum asperun	---	---	---	---	---	---	Tr/5	---
Gaura coccinea	---	---	---	---	1/10	Tr/10	---	---
Helianthus nuttallii	---	---	---	Tr/5	---	---	---	---
Leguminosae	1/5	---	---	1/5	---	---	---	---
Leucocrinum montanum	---	---	---	---	---	---	2/15	---
Linum perenne	---	Tr/10	---	---	---	---	---	---
Linum rigidum	Tr/5	---	---	Tr/5	---	---	---	---
Lupinus spp.	---	---	---	---	---	---	---	1/10
Melilotus officinalis	---	---	---	---	1/5	---	---	---
Oenothera serrulata	---	---	---	---	---	---	---	Tr/20
Opuntia polyacantha	1/10	Tr/5	---	1/5	---	---	---	---
Orthocarpus luteus	---	---	---	---	---	---	1/5	---

TABLE XI-3.--Plant canopy coverage and frequency of low-growing taxa in eight natural plant communities within the mine control area--Continued

Taxa	Plant community transect code							
	111.2-C	111.3-C	111.4-C	211-C	212.1-C	212.2-C	213-C	351-C
Forbs--Continued								
Oxytropis besseyi	---	---	1/5	---	---	---	---	---
Petalostemon purpureus	---	---	1/5	---	---	---	---	Tr/5
Petalostemon spp.	---	---	Tr/5	---	---	---	---	---
Phacelia spp.	---	---	---	---	---	---	---	1/20
Phlox hoodii	---	1/20	Tr/5	4/40	---	Tr/15	---	Tr/5
Plantago purshii	---	1/15	---	Tr/15	---	Tr/5	---	Tr/10
Plantago spinosa	---	---	---	---	---	---	2/30	---
Psoralea argophylla	1/10	5/35	3/20	---	6/40	6/35	6/45	---
Ratibida columnifera	---	---	---	---	---	2/15	---	---
Sonchus oleraceus	---	---	Tr/5	---	3/25	1/5	---	---
Sphaeralcea coccinea	Tr/5	4/40	1/20	3/30	---	4/40	1/15	---
Taraxacum officinale	1/10	2/10	---	Tr/5	14/80	4/30	---	---
Tragopogon dubius	8/55	1/15	---	1/10	5/30	1/5	---	---
Vicia americana	---	---	---	---	---	---	---	5/30
Yucca glauca	---	---	1/5	---	---	---	---	Tr/5
Zigadenus venenosus	---	---	---	---	---	---	---	Tr/10
Unknown forbs	---	---	---	---	---	---	Tr/10	---
Total	14/85	18/95	11/80	9/85	26/95	19/80	29/85	8/75
Shrubs:								
Artemisia cana	---	---	---	---	24/55	21/50	---	---
Artemisia tridentata	---	---	---	16/50	---	---	---	---
Gutierrezia sarothrae	---	1/5	---	---	---	---	---	---
Rhus trilobata	---	---	---	---	---	---	12/25	5/25
Total	---	1/5	---	16/50	24/55	21/50	12/25	5/25

TABLE XI-3.--Percent canopy coverage and frequency of low-growing taxa in eight natural plant communities within the mine control area--Continued

Taxa	Plant community transect code							
	111.2-C	111.3-C	111.4-C	211-C	212.1-C	212.2-C	213-C	351-C
Ground characteristics:								
Bare ground	46/100	36/100	32/95	41/100	3/25	20/85	19/85	6/35
Rock	---	---	---	---	---	---	---	7/40
Lichen	5/80	4/80	1/10	---	---	---	1/5	1/5
Standing litter	1/5	---	13/65	7/30	29/90	4/25	---	8/60
Down litter	22/95	22/100	25/100	22/95	28/100	20/90	22/100	68/100

[1]Plant community-transect code numbers correspond with those defined in table 1.
[2]Average percent canopy coverage/frequency among plots in each transect.
[3]Tr = Trace; a value less than 0.5 percent.

Appendix F-3.--The five noxious vegetative species in Rosebud County

Common name	Scientific name
Bindweed	*Convolvulus arvensis*
Canada thistle	*Cirsium arvense*
Leafy spurge	*Euphorbia esula*
Russian knapweek	*Centaurea repens*
Whitetop	*Cardaria draba*

Appendix G-1.--List of animals observed in the vicinity of Colstrip

Common name	Scientific name
Mammals	
Pronghorn antelope-------------	Antilocapra americana
Coyote------------------------	Canis latrans
Black-tailed prairie dog-------	Cynomys ludovicianus
Porcupine---------------------	Erethizon dorsatum
Least chipmunk----------------	Eutamias minimus
White-tailed jackrabbit--------	Lepus townsendii
Bobcat------------------------	Lynx rufus
Yellow-bellied marmot----------	Marmota flaviventris
Striped skunk-----------------	Mephitis mephitis
Prairie vole------------------	Microtus ochrogaster
House mouse-------------------	Mus musculus
Longtail weasel---------------	Mustela frenata
Little brown bat--------------	Myotis lucifugus
Mule deer---------------------	Odocoileus hemionus
White-tailed deer-------------	Odocoileus virginianus
Muskrat ----------------------	Ondatra zibethicus
Western deer mouse------------	Peromyscus maniculatus
Raccoon-----------------------	Procyon lotor
Masked shrew------------------	Sorex cinereus
Thirteen-lined ground squirrel-	Spermophilus tridecemlineatus
Desert cottontail-------------	Sylvilagus audubonnii
Badger------------------------	Taxidea taxus
Northern pocket gopher---------	Thomomys talpoides
Red fox-----------------------	Vulpes vulpes
Birds	
*Spotted sandpiper-------------	Actitis macularia
*White-throated swift----------	Aeronautes saxatalis
Red-winged blackbird-----------	Agelaius phoeniceus
*Grasshopper sparrow-----------	Ammodramus savannarum
Pintail-----------------------	Anas acuta
Greenwing teal----------------	Anas carolinensis
Cinnamon teal-----------------	Anas cyanoptera
Blue-winged teal--------------	Anas discors
Mallard-----------------------	Anas platyrhynchos
Gadwall-----------------------	Anas strepera

Appendix G-1.--List of animals observed in the vicinity of Colstrip--Continued

Common name	Scientific name
Birds--Continued	
Golden eagle---------------	Aquila chrysaetos
Great blue heron----------	Ardea herodias
*Short-eared owl-----------	Asio flammeus
Upland plover-------------	Bartramia longicauda
Canada goose--------------	Branta canadensis
Great horned owl----------	Bubo virginianus
Red-tailed hawk-----------	Buteo jamaicensis
Rough-legged hawk---------	Buteo lagopus
Lark bunting--------------	Calamospiza melanocorys
*Common snipe--------------	Capella gallinago
Sage grouse---------------	Centrocercus urophasianus
Killdeer------------------	Charadrius vociferus
Lark sparrow--------------	Chondestes grammacus
Common night hawk---------	Chordeiles minor
Marsh hawk----------------	Circus cyaneus
*Yellow-billed cuckoo------	Coccyzus americanus
Red-shafter flicker-------	Colaptes cafer
*Western wood pewee--------	Contopus sordidulus
Common crow---------------	Corvus brachyrhynchos
*Audubon warbler-----------	Dendroica auduboni
Yellow warbler------------	Dendroica petechia
*Catbird-------------------	Dumetella carolinensis
*Dusky flycatcher----------	Empidonax oberholseri
Horned lark---------------	Eremophila alpestris
Rusty blackbird-----------	Euphagus carolinus
Brewer's blackbird--------	Euphagus cyanocephalus
Sparrow hawk--------------	Falco sparverius
*Prairie falcon------------	Falco mexicanus
American coot-------------	Fulica americana
*Yellowthroat--------------	Geothlypis trichas
Pinyon jay----------------	Gymnorhinus cyanocephala
*Bald eagle----------------	Haliaeetus leucocephalus
Barn swallow--------------	Hirundo rustica
*Yellow-breasted chat------	Icteria virens
*Bullock's oriole----------	Icterus bullockii
Slate-colored junco-------	Junco hyemalis
Loggerhead shrike---------	Lanius ludovicianus
*Red crossbill-------------	Loxia curvirostra

Appendix G-1.--List of animals observed in the vicinity of Colstrip--Continued

Common name	Scientific name
Birds--Continued	
American widgeon----------	Mareca americana
Red-headed woodpecker-----	Melanerpes erythrocephalus
*Song sparrow--------------	Melospiza melodia
Brown-headed cowbird------	Molothrus ater
Black-capped chickadee----	Parus atricapillus
House sparrow-------------	Passer domesticus
Sharp-tailed grouse-------	Pedioecetes phasianellus
Hungarian partridge-------	Perdix perdix
*Cliff swallow-------------	Petrochelidon pyrrhonota
Ring-necked pheasant------	Phasianus colchicus
*Blackheaded grossbeak-----	Pheucticus melanocephalus
Magpie--------------------	Pica pica
*Rufous-sided towhee-------	Pipilo erythrophthalmus
Vesper sparrow------------	Pooecetes gramineus
McCown's longspur---------	Rhynchophanes mccownii
Bank swallow--------------	Riparia riparia
*Rock wren-----------------	Salpinctes obsoletus
Say's phoebe--------------	Sayornis saya
*American redstart---------	Setophaga ruticilla
Mountain bluebird---------	Sialia currucoides
Red-breasted nuthatch-----	Sitta canadensis
White-breasted nuthatch---	Sitta carolinensis
Shoveller-----------------	Spatula clypeata
American goldfinch--------	Spinus tristis
Tree sparrow--------------	Spizella arborea
Brewer's sparrow----------	Spizella breweri
*Clay-colored sparrow------	Spizella pallida
*Chipping sparrow----------	Spizella passerina
Wilson's phalarope--------	Steganopus tricolor
*Rough-winged swallow------	Stelgidopteryx ruficollis
Western meadowlark--------	Sturnella neglecta
Starling------------------	Sturnus vulgaris
Violet-green swallow------	Tachycineta thalassina
Brown thrasher------------	Toxostoma rufum
House wren----------------	Troglodytes aedon
Robin---------------------	Turdus migratorius
Eastern kingbird----------	Tyrannus tyrannus
Western kingbird----------	Tyrannus verticalis

Appendix G-1.--List of animals observed in the vicinity of Colstrip--Continued

Common name	Scientific name
Birds--Continued	
*Red-eyed vireo------------	Vireo olivaceus
Mourning dove-------------	Zenaidura macroura
White-crowned sparrow-----	Zonotrichia leucophrys
Reptiles	
Common snapping turtle---	Chelydra serpentina
Western painted turtle---	Chrysemys picta
Racer--------------------	Coluber constrictor
Prairie rattlesnake------	Crotalus viridis
Hognose snake------------	Heterodon nasicus
Bull snake---------------	Pituophis catenifer
Sagebrush lizard---------	Sceloperous graciosus
Amphibian	
Leopard frog--------------	Rana pipiens

* Denotes Audubon Society observations along Colstrip-Brandenburg route (Roney and Phelps (1968-74).

Appendix G-2.--Wildlife associated with sandstone outcroppings at the Big Sky mine

The following is a list of wildlife observed at the various sandstone outcroppings at the Peabody Big Sky coal mine in Colstrip, Montana. The observations were made via foot on three consecutive days in July 1978. This list, hwoever, is in no way meant to be complete for there are obviously species that will have gone unnoticed by the observer; there may be nocturnal species; and some species may show seasonal preference. However, this may shed some light on the diversity of species using and/or associated with these sandstone outcroppings.

		Approximate number seen
Rock outcrop No. 1		
Birds:		
Mourning dove-------	*Zenaidura macroura*---------	3
Great horned owl----	*Bubo virginianus*-----------	1
Red-shafted flicker-	*Colaptes cafer*-------------	2
Cliff swallow-------	*Petrochelidon pyrrhonota*---	65-70
Rock wren-----------	*Salpinctes obsoletus*-------	4
Lark sparrow--------	*Chondestes grammacus*-------	4
Chipping sparrow----	*Spizella passerina*---------	2
Mammal:		
Least chipmunk------	*Eutamias minimus*-----------	5
Rock outcrop No. 2		
Birds:		
Mourning dove ------	*Zenaidura macroura*---------	3
Rock wren-----------	*Salpinctes obsoletus*-------	1
House wren----------	*Troglodytes aedon*----------	1
Mountain bluebird---	*Sialia currucoides*---------	4
Flycatcher unk sp.--	*Drosophyllum*---------------	1
Western wood pewee--	*Contopus sordidulus*--------	1
Savannah sparrow----	*Passerculus sandwichensis*--	2
Lark sparrow--------	*Chondestes grammacus*-------	2
Mammal:		
Least chipmunk------	*Eutamias minimus*-----------	4

Appendix G-2.-- Wildlife associated with sandstone outcroppings at the Big Sky mine--Continued

		Approximate number seen
Rock outcrop No. 3		
Birds:		
Sparrow hawk	*Falco sparverius*	2
White throated swift	*Aeronautes saxatalis*	2
Lark sparrow	*Chondestes grammacus*	1
Chipping sparrow	*Spizella passerina*	1
Mammals:		
Coyote	*Canis latrans*	1
Least chipmunk	*Eutamias minimus*	2
Rock outcrop No. 4		
Birds:		
Sparrow hawk	*Falco sparverius*	1
Red-headed woodpecker	*Malanerpes erythrocephalus*	1
Red-shafted flicker	*Colaptes cafer*	1
Flycatcher unk sp.	*Drosophyllum*	1
Black-capped chickadee	*Parus atricapillus*	2
Mammal:		
Least chipmunk	*Eutamias minimus*	2
Reptile:		
Sage-brush lizard	*Schleoperous graciosus*	4

Appendix G-2.--Wildlife associated with sandstone outcroppings at the Big Sky mine-- Continued

		Approximate number seen
Rock outcrop No. 5		
Birds:		
Mourning dove--------	*Zenaidura macroura*--------	2
Rock wren------------	*Salpinctes obsoletus*------	3
Lark sparrow---------	*Chondestes grammacus*------	2
Mammal:		
Least chipmunk-------	*Eutamias minimus*----------	1
Rock outcrop No. 6		
Birds:		
Sparrow hawk---------	*Falco sparverius*----------	4
White throated swift-	*Aeronautes saxatalis*------	15-20
Violet-green swallow-	*Tachycineta thalassina*----	2
Rock wren------------	*Salpinctes obsoletus*------	4
House wren-----------	*Troglodytes aedon*---------	4
Reptile:		
Sage-brush lizard----	*Schleoperous graciosus*----	5

Appendix I-1.--Summary of Montana tax laws for State and county jurisdiction

[Source: Montana Taxpayers Association, Tax laws of Montana with amendments of 1974 Legislature, Helena, Montana, 1974]

	Maximum mill limit
State property taxes:	
General fund	2.00
University fund	6.00
Statewide deficiency levy for public schools	As needed
Statewide public school supplemental permissive levy	9.00
Special livestock	9.00
Property tax administration (repealed)	----
Total	21.00
County property taxes:	
General fund	25.00-27.00
Poor fund	13.5
Bond sinking and interest	As necessary
Road	12.00
Emergency levies	2.00
Employee retirement	
Bridge tax	3.00-5.00
Special bridge and road tax	10.00-5.00
Airport tax	2.00
Airport authority	No limit
Public ferry tax	2.00
County fair tax	1.50
Library tax	3.00
Rodent control tax	2.00
Insect pest tax	1.00
Weed control	2.00
Extension work in agriculture and home economics	No limit
Fire districts	As necessary
Soil conservation districts	1.50
Conserving districts	2.00-5.00
Cemetery	2.00
Local boards of health county	2.00
Museum fund tax	0.50
Mosquito control district	5.00
Planning and zoning	2.00-6.00
Hospital districts	3.00
County park commission	As needed
Civic center tax	2.00
Special improvement district	
Ambulance services levy	1.00
Recreational program-elderly	1.00

Appendix I-2.--Taxable valuations for Rosebud County, Montana, and mill levies by State and Rosebud County, Montana, for 1969-70 through 1977-78

[Source: Montana property tax mill levies, 1970 through 1978, Montana Taxpayers Association, Helena, Montana]

	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
Taxable valuations-------	10,559,430	12,515,430	13,709,670	18,121,757	19,612,993	25,666,296	42,957,995	70,704,358
State levy---------------	8.200	8.300	6.100	6.000	21.000	6.000	5.600	6.000
County levy:								
General----------------	18.720	18.231	18.565	[2]12.424	[3]16.310	[4]9.522	2.954	3.448
Road[1]------------------	11.867	12.000	13.397	10.557	11.929	9.995	11.999	11.761
Bridge-----------------	4.987	4.004	5.000	4.232	3.908	3.982	1.428	1.819
Poor-------------------	5.335	5.460	5.232	7.920	4.649	3.598	2.619	1.219
Fair-------------------	1.500	1.419	1.233	.892	.792	.991	.812	.472
Library----------------	2.880	2.975	1.614	1.248	1.271	1.010	.822	.490
Airport----------------	.243	.097	.268	1.845	1.525	1.558	.225	1.108
Weed-------------------	.919	.885	2.000	1.682	1.991	.929	.808	.744
Cemetery---------------	.435	.496	.469	.473	.311	.404	.158	.183
Bond interest & sinking	.953	.252	5.474	3.437	3.029	2.265	1.202	.732
Museum-----------------	.493	.493	.355	.288	.216	.130	.138	.066
Reclassification-------	.000	.595	.944	.439	.000	.000	.000	.000
Senior citizens--------	.000	.000	.000	.000	.000	.000	.883	.075
Pest-------------------	.000	.000	.000	.000	.000	.000	.000	.000
County levy total-----	48.332	46.907	54.551	45.437	45.930	34.384	24.048	22.117
High school total--------	19.13	18.84	18.19	16.84	22.26	17.34	19.64	17.360
General----------------	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.000
Deficiency-------------	1.73	2.14	1.10	.03	4.20	.00	1.50	.600
Transportation---------	1.24	.79	1.23	.94	.90	.65	.82	.570
Retirement-------------	1.16	.91	.86	.87	2.16	1.69	2.32	1.190
General school total-----	27.83	28.95	27.04	27.14	37.01	30.46	30.74	28.570
General----------------	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.000
Deficiency-------------	2.83	3.95	2.04	2.14	7.80	.00	2.40	1.000
Retirement-------------	0.00	0.00	0.00	0.00	4.21	5.46	3.34	2.570
Grand total---------	103.492	102.997	105.881	95.417	126.20	88.184	80.028	74.047

[1]Not levied against taxable valuation of municipalities.
[2]Includes 0.243 mill for crime control.
[3]Includes 0.297 mill for crime control.
[4]Includes 0.652 mill for crime control.

Appendix I-3.--Revenues by source in thousand dollars for Rosebud County, Montana

[Source: County Clerk's annual report to State Examiner, Rosebud County, Montana for fiscal year ending June 30. No data available for 1971 or 1973]

	1970	1972	1974	1975	1976
Receipts taxes-----	492.19	747.82	960.72	924.59	1,023.27
Miscellaneous revenue--------	133.11	279.35	518.15	1,250.79	1,490.75
Fee and charges--	10.17	9.83	19.36	26.51	24.08
License and permit---------	.77	.74	1.26	218.66	361.08
Fine, penalties--	.86	.00	17.25	26.42	19.67
Gift and grants--	4.49	9.14	275.59	606.89	380.18
Other------------	116.82	126.53	240.19	373.31	705.74
Auto registration--------	37.41	42.93	60.69	69.78	70.81
Tax deeds--------	24.89	38.31	135.05	246.94	574.23
Highway use------	1.51	2.13	31.13	38.82	43.80
Interest-----------	18.04	67.60	88.14	161.97	85.20
Collections and commission---	10.55	11.46	16.03	17.85	22.96
County fair------	9.41	9.33	12.78	11.95	16.65
Airport----------	.49	.72	.15	2.19	1.10
Library----------	.12	.76	1.26	1.73	2.00
Cemetery lots----	.18	.30	.41	.16	.14
Other[1]-----------	.36	.36	.03	1.82	3.09
Refunds-incoming---	21.82	34.91	111.11	160.00	199.79
Clerk------------	.20	.20	.51	.09	.39
Commissioners, Treasurer, Assessor-------	.01	.06	.19	.45	.95
Highways---------	.94	2.59	13.51	33.06	81.90
Bridges----------	.85	5.76	11.57	16.62	14.73
State welfare----	1.62	3.10	4.25	.91	1.21
Unclassified[3]----	13.76	21.17	33.98	28.24	20.51
Sheriff----------	.00	.00	38.56	76.92	67.47
Other[2]-----------	2.57	2.02	8.55	3.90	2.42

Appendix I-3.--Revenues by source in thousand dollars for Rosebud County, Montana--Continued

	1970	1972	1974	1975	1976
Normal receipts----	1,022.60	1,948.54	2,291.73	3,026.78	4,138.16
Sinking funds----	.00	628.39	.00	.00	.00
Investments------	.00	.00	17.09	.00	.00
Transfers--------	510.58	659.12	1,167.67	1,515.33	2,069.08
Between company funds---	8.28	29.08	71.88	197.48	29.64
Trust and agency-------	502.90	630.04	1,035.09	1,315.86	2,039.44
Miscellaneous sale land------	.65	1.79	.00	.00	.00
Offset outlay-miscellaneous----	.19	.12	100	.11	.00
Trust and agency-----------	1,802.06	2,034.58	3,442.03	5,781.13	8,153.43
State------------	161.85	166.23	582.61	338.11	578.10
Cities and town-----------	94.05	111.86	156.15	194.85	258.96
General school---	291.68	385.39	620.87	801.25	1,226.24
District school--	609.96	682.29	1,137.49	2,515.98	3,318.00
Irrigation-------	87.16	82.77	83.97	89.84	103.73
Estates----------	39.29	20.98	56.69	25.17	60.33
District court deposit--------	.00	30.04	66.97	140.96	93.66
Protested taxes--	1.93	.00	3.64	73.18	24.02
General high school---------	197.98	255.55	378.15	452.10	776.62
District high school---------	316.88	294.08	351.16	1,146.01	1,708.06
Other[3]-----------	1.88	2.31	4.33	3.77	5.68
Total[4]--------	2,989.19	4,332.05	6,296.95	9,809.78	13,044.48

[1]Includes selective service rent and Board of Health.

[2]Includes fairs, civil defense, direct relief, foster homes, library, cemetery, and county hospital.

[3]Includes migratory stock and redemptions

[4]May not add due to rounding error.

Appendix I-4.--Montana coal severance tax

The Coal Severance Tax Act and rules adopted thereunder impose a severance tax of up to 30 percent of the value of coal removed by surface mining methods. The taxes collected are allocated as follows:

"(1) To the county for such purposes as the governing body of that county may determine from which coal was mined for each calendar year prior to January 1," 1980, three cents (3¢) per ton or four percent (4%) of the severance tax paid on the coal mined in that county, whichever is higher, and for each calendar year following December 31, 1979, three cents (3¢) per ton or three and one-half percent (3.5%) of the severance tax paid on the coal mined in that county, whichever is higher.

"(2) Two and one-half percent (2.5%) of total collections per year until December 31, 1979, and thereafter four percent (4%) of total collections per year to the earmarked revenue fund, to the credit of the alternative energy research development and demonstration account.

"(3) Twenty-seven and one-half percent (27.5%) of total collections per year, until July 1, 1979, and thereafter thirty-five percent (35%), to the earmarked revenue fund to the credit of the local impact and education trust fund account.

"(4) For each of the four (4) fiscal years following the effective date of this act ten percent (10%) of total collections per year to the earmarked revenue fund to the credit of the coal area highway improvement account.

"(5) Ten percent (10%) of total collections per year, to the earmarked revenue fund, for state equalization aid to public schools of the state.

"(6) For the period ending December 31, 1979, one percent (1%) of total collections per year to the earmarked revenue fund, the the credit of the county land planning account.

"(7) Two and one-half percent (2.5%) of total collections per year to the sinking fund, to the credit of the renewable resource development bond account.

"(8) Two and one-half percent (2.5%) of total collections per year through June 30, 1979, of which portion one-half (.5%) shall be allocated to the earmarked revenue fund, for the purpose of acquisition of sites and areas described in section 62-304, subject to legislative appropriations, and one-half (.5%) shall be allocated to the trust and legacy fund, for the purpose of parks acquisition. Income from the fund established in this subsection may be appropriated for the acquisition of sites and areas described in section 62-304.

Appendix I-4.--Montana coal severance tax--Continued

"(9) To the earmarked revenue fund, such portions of the severance tax as may be authorized by laws enacted in 1975.

"(10) All other revenues from license of severence taxes collected under the provisions of this chapter shall be deposited to the credit of the general fund of the state."

Appendix J-1.--Survey of housing conditions, Rosebud County, 1975

[Source: Rosebud County Housing Assistance Plan, 1975]

	Total	Subtotal suitable for rehabilitation
Occupied units	3,081	1,225
Substandard	1,225	232
Standard & other	1,856	993
Vacant available units	40	16
Substandard	16	3
Standard	24	13
Total Units	3,121	1,241

Appendix J-2.--Rosebud County water systems

Locale	Source	Treatment	Storage	Adequacy
Forsyth	Yellowstone	3.5 mgpd	3 mg	yes*
Colstrip	Yellowstone	1000 gpm	.5 mg	yes
Lame Deer	wells	135 gpm	.4 mg	barely
Ashland	wells	.72 mgpd	?	until 1985
Birney	private	NA	NA	NA

*for a population to 22,000
mgpd - million gallons per day
NA - not applicable
gpm - gallons per minute
mg - million gallons

Appendix J-3.--Rosebud County wastewater treatment systems

Locale	Type	Present Population	Design Population
Forsyth	Municipal	2,500	5,000
Colstrip	Municipal	1,800	1,200
Lame Deer	Municipal	?	?
Ashland	Municipal	?	?
Birney	Private septic tanks	----------------not applicable----	

Appendix J-4.--Rosebud County selected crime statistics: 1970-1977

[Source: Criminal Justice Data Center, Montana Board of Crime Control]

	Violent Crimes				Property Crimes			
Year	Murder	Rape	Robbery	Assault	Burglary	Larceny theft	Motor Vehicle theft	Total
1970----------				4		12		16
1971----------		2	2	10	61	183	18	276
1972----------		1	1	7	28	51	8	96
1973----------								
No. Cheyenne--	1	3		36	6	9	2	57
County--------		2		15	20	53	8	98
								135
1974								
No. Cheyenne--	1	3		55	11	20	1	91
County--------	2	4	1	7	19	68	8	109
								200
1975								
No. Cheyenne--		1		78	2		2	83
County--------	1	2		14	36	104	5	162
								245
1976								
No. Cheyenne--		4		52	33	15	1	105
County--------		1		11	53	104	24	193
								298
1977								
No. Cheyenne--	2	6	7	72	9	9	3	108
County--------	3			5	24	74	5	111
								219

NOTE: Population in the County increased from 6,032 in 1970 to 9,551 in 1976.

Appendix J-5.--County Attorney caseload: prosecutions - 1975-1977

[Source: John Forsyth, Rosebud County Attorney]

Crime	No. of Cases Filed Charges	Convictions
Homicide	7	5
Burglary	11	9
Sex Crimes	5	3
Aggravated Assault	10	6
Felony - bad checks	7	5
Dangerous drugs	4	4
sale of	4	2
Criminal Mischief	2	1
Sale of Explosives	5	5
Grand Theft	6	8
Kidnapping	2	1
Misdemeanors		
1975	73	40
1976	90	62
1977	95	70 (18 pending)

(Most frequent: bad checks and reckless driving)

Appendix J-6.--Proportion of Forsyth municipal revenues allocated to selected functions - FY 1978

[Source: John Forsyth, Rosebud County Attorney]

Function	Amount	Percent
All-purpose fund -------	$ 433,945	100.00
Police department ----	57,269	13.2
Police court ---------	2,467	.6
Fire department ------	7,433	1.7
Sewer department -----	773,384*	
Water department -----	511,454*	
Solid waste ----------	227,057*	
Streets --------------	22,963	5.3
Parks and playgrounds-	18,371	4.2

*Revenues from fees and grants and not generated by property taxation.

Appendix J-7.--Proportion of Rosebud County revenues allocated to selected functions - FY 1978

Function	Amount	Percent
General fund	$2,225,184	100.00
Sheriff's Office	365,411	16.4
County Attorney	74,946	3.4
Fire Protection	7,000	.3
Health	45,640	2.1
Alcohol and Drug Abuse Program	18,930	.9
Solid Waste	150,000	6.7
Rodent Control	21,000	.9
Poor fund	163,484	100.00
Aid to Dependent Children	4,500	2.7
Non-Reimbursable Welfare Costs	15,350	9.4
State Reimbursement for Welfare Expenditures	77,104	47.2
Nursing Home	10,000	6.1
Library fund	48,539	100.00

Appendix K-1.--Range condition classification and recommended stocking rates for five natural plant communities

[This information is a portion of Table IV in Peabody Coal Company Big Sky mine annual small mammal and vegetation report for 1976 (ECON, 1976)]

Plant community	Date	SCS range site[1]	Condition classification[2]	Recommended stocking rate[3]
(111.2) Grassland (POSE-KOCR-STCO)--------	6/28/76	Silty	[4]Fair (27)	0.20
(111.3) Grassland (AGSM-KOCR-STCO)--------	6/23/76	Silty	Good (53)	0.30
(111.4) Grassland (CALO-ANSC-ANGE)--------	6/23/76	Sandy	Good (67)	0.30
(212.1) Silver sagebrush-coulee (ARCA-AGSM-POPR)--------	6/30/76	Silty	Fair (42)	0.20
(212.2) Silver sagebrush-bench (ARCA-AGSM-KOCR)--------	6/28/76	Silty	Fair (42)	0.20

[1]Follows SCS criteria.
[2]Based on canopy coverage and 10-14" precipitation zone chart.
[3]In AUM's/acre.
[4]Poor = 0-24; fair= 25-49; good = 50-74; excellent = 75-100.

Appendix K-2.--Summary of the annual plant biomass production from five natural plant communities

[This information is a portion of Table V in Peabody Coal Company Big Sky mine annual small mammal and vegetation report for 1976 (ECON, 1976)]

Plant community	forage classes	Production per forage class (lb/acre)	Production per plant community (lb/acre)
(111.2) Grassland----------	Perennial grass--	524.32	
(POSE-KOCR-STCO)	Annual grass-----	9.28	
	Forb-------------	82.06	
	Shrub------------	14.09	
			629.75
(111.3) Grassland----------	Perennial grass--	411.93	
(AGSM-KOCR-STCO)	Annual grass-----	87.42	
	Forb-------------	130.05	
	Shrub------------	5.35	
			634.75
(111.4) Grassland----------	Perennial grass--	550.54	
(CALO-ANSC-ANGE)	Annual grass-----	16.95	
	Forb-------------	60.30	
	Shrub------------	3.03	
			630.82
(212.1) Silver sagebrush-coulee-------------	Perennial grass--	139.15	
(ARCA-AGSM-POPR)	Annual grass-----	97.41	
	Forb-------------	27.65	
	Shrub------------	384.99	
			649.20
(212.2) Silver sagebrush-bench--------------	Perennial grass--	335.57	
(ARCA-AGSM-KOCR)	Annual grass-----	52.63	
	Forb-------------	89.02	
	Shrub------------	41.57	
	Lichen-----------	0.54	
			519.33

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Miles City District Office
P.O. Box 940
Miles City, Montana 59301

In Reply refer to
3500
XI-47

RECEIVED
9/5/78

Appendix N-1

August 31, 1978

George Robinson
Peabody Coal Co.
12075 E. 45th Ave.
Suite 203
Denver, CO 80239

Dear Mr. Robinson:

This letter is to confirm that September 15, 1978, has been set for a meeting with you and your representatives to discuss cultural resources within the Peabody Big Sky Mine. The meeting will be held at the Bureau of Land Management Office in Billings and is scheduled to begin at 8:00 A.M.

I am enclosing a map of the Peabody area outlining what appears to have been covered by earlier cultural resource surveys. If the permit boundary shown is correct, an additional survey is needed to adequately cover that area.

I have also enclosed a list of archaeologists who have Federal Antiquities Act Permits to conduct cultural resource inventories and mitigation work for private industry within the state of Montana.

Contact Jim Murkin of our office should you need further information.

Sincerely yours,

Signed

Acting District Manager

Enclosures

United States Department of the Interior

XI-48

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

RECEIVED 8/25/78

OFFICE OF THE DIRECTOR

In Reply Refer To:
EGS-Mail Stop 108

22 AUG 1978

Mr. Louis S. Wall
Assistant Director, Office
of Review and Compliance
Advisory Council on Historic Preservation
1522 K Street, N.W.
Washington, D.C. 20005

Dear Mr. Wall:

We are responding to your letters of August 11, 1978, and November 16, 1976, making further inquiries in the matter of compliance with Executive Order 11593 and related legislation by the Geological Survey attendant to approval of the mining and reclamation plan of Peabody Coal Company for its Big Sky Mine, Montana.

The earlier of your two letters makes reference to our final environmental statement on this action (FES 74-12), and we recommend it to your further attention and perusal. Pages 1-8 fully identify the Federal action involved--that is, approval to mine as proposed the federally owned, previously leased, coal underlying a part of Section 22, even though Peabody holds vastly larger contiguous coal that may be mined in the future. Should any of the additional Federal coal already under lease be proposed for mining, further prior approval by the Department of the Interior would be required. After July 5, 1978, this would be the responsibility of the Office of Surface Mining rather than the Geological Survey.

The FES also relates that all of the land surface to be disturbed is privately owned. This means that the Montana State Lands Department must also approve the plan and all future mining on those holdings under relevant State and Federal laws.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

2

Our final statement, page 102-105, details the extent of cultural, historic, and archeological surveys accomplished, as well as the results of review by the State Historic Preservation Officer (SHPO) of that proposal and the surveys conducted to that point in time. The quotation of the State Historic Preservation Officer made on page 105 of the statement clearly establishes that Section 2(b) of the Executive Order has been addressed and was not applicable to this mining proposal.

These matters were discussed in some detail by the National Park Service in its official comments on the draft statement. Those comments and our responses are found in Appendix 12 of the final statement at pages 83-86. As you know, the final statement was filed with CEQ on March 7, 1974.

For your information the Under Secretary of the Interior authorized our approval of the Peabody proposal on April 23, 1974, and it was so approved by our Area Mining Supervisor on April 29, 1974.

With respect to the three issues raised in your letter of November 19, 1976:

(1) As noted above, Section 2(b) of Executive Order was considered and duly demonstrated as not applicable to the Federal action under consideration.

(2) As noted above, a Federal permit to mine the limited area of the Federal coal lease, as proposed, was issued on April 29, 1974, by the Geological Survey.

(3) As noted in the final statement, page 3, Federal coal lease M-15965 was issued on April 1, 1971, by the Bureau of Land Management prior to issuance of Executive Order 11593. We recommend that you consult with the State Director, BLM, Billings, Montana, relative to the leasing action.

In the matter of our compliance with relevant law and regulation, at such time as additional portions of the existing Federal lease may be proposed for mining by the lessee, our letter of October 18, 1976, clearly states our position in the matter: full compliance will be requisite to further authorization to mine.

Sincerely yours,

Signed
Acting Director

Copy to: State Director, BLM, Billings, Montana
Director, Office of Surface Mining

cc: General Files, MS114/Reston
Dir. Chron MS114
Mr. David Hales, Interior Representiative-ACHP
Chief, CD-MS600
Chief, EIAP-MS760
Mr. Glen Malmberg, Billings, Mont.
Mr. Stewart MS108

EGS:HGStewart:ga:8/21/78:860-7493
RETYPED:8/2278

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

August 11, 1978

Appendix N-3

Mr. Henry W. Coulter
Acting Director
U.S. Geological Survey
United States Department
of the Interior
Reston, Virginia 22092

Dear Mr. Coulter:

By letter of November 19,1976, the Council requested that you clarify your letter of October 18, 1976, regarding the Geological Survey's compliance with Section 2(b) of Executive Order 11593, "Protection and Enhancement of the Cultural Environment" of May 13, 1971, for its issuance of Coal Lease M-15965 to the Peabody Coal Company for the Big Sky Mine, Colstrip, Montana. A copy of your letter and our request is enclosed for your convenience.

To date the Council has received no response to this request. We would appreciate it if you would look into this matter and let us have a reply as soon as possible. If you have any questions, please call Brit Allan Storey of the Council's Denver staff at (303) 234-4946, an FTS number.

Sincerely yours,

Signed

Louis S. Wall
Assistant Director, Office
of Review and Compliance

Enclosures

PEABODY COAL COMPANY

power for progress

ROCKY MOUNTAIN DIVISION

45th & Peoria St., Montbello Office Building, Denver, Colorado, 80239, Phone (303) 371-7990

August 3, 1978

Ms. Edrie Binson
Montana State Preservation Office
225 N. Roberts Street
Helena, Montana 59601

Dear Ms. Binson:

Enclosed you will find the information requested during our telephone conversation on July 31, 1978. I have enclosed the archaeological report prepared by Mr. Dale E. Fredlund entitled, "Archaeological Reconnaissance and Salvage Excavation on Peabody Coal Lands, Rosebud County, Montana" and a report prepared by Ms. Carolyn Ekland entitled, "Salvage Excavation at the BLM Bison Trap" (24RB-1021).

I have also enclosed Exhibit G, Classified Archaeological Sites, and a 1978 permit boundary map. In addition, I have enclosed the archaeological information which was compiled for the Big Sky EIS, published by the Department of Interior on March 7, 1974.

If additional information is required, please do not hesitate to contact me.

Sincerely,

George M. L. Robinson
Senior Hydrologist

GMLR:slh
Enclosures
cc: J. Murkin
R. Juntunen

MONTANA HISTORICAL SOCIETY

225 NORTH ROBERTS STREET • (406) 449-2694 • HELENA, MONTANA 59601

July 18, 1978

Mr. George Neuberg, District Manager
Bureau of Land Management
Box 940
Miles City, Montana 59301

RE: Peabody Coal Strip Mine
Cultural Resources

Attention: Jerry Clark & Jim Merkin

Dear Mr. Neuberg:

The next step in the process of compliance with Section 106 of the Historic Preservation Act for sites identified within the Peabody Coal Lease Area is to request a determination of eligibility as required in 36CFR800.4 (a) (2). As I understand it, there are 27 sites to which the criteria should be applied for opinion of eligibility. Nine of these have been recommended for testing to determine eligibility. I am not aware of any current testing projects, and recommend that you take steps to arrange for testing to begin.

As soon as determinations are made by the Secretary of Interior, we will be happy to assist you in applying the criteria for effect (36CFR800.8) for any sites determined eligible.

Your prompt attention to this matter will be greatly appreciated.

Sincerely,

Ken Korte
State Historic Preservation Officer

cc: Dick Jutenen
Department of State Lands
Helena, Montana 59601

Doug Heilman
USGS, Office of Area Mining Supervisor
P. O. Box 2550
Billings, Montana 59103

Appendix N-6

NCV 19 1976

Mr. Henry W. Colter
Acting Director
U.S. Geological Survey
United States Department
of the Interior
Reston, Virginia 22092

Dear Mr. Coulter:

This is in response to your letter of October 18, 1976, regarding the development of the Peabody Coal Company's Big Sky Mine, Coal Lease M-15965, Colstrip, Montana. As noted in the council's letter of August 20, 1976, the final environmental statement (FES) for this undertakng identified several archeological resources which would be destroyed by the proposed coal mining operations on Coal Lease M-15965. In addition, it was noted that 3,300 acres of affected land had not been surveyed for cultural resources at the time of the FES. It is noted that your letter clarifies that "all requirements for identification, protection, and consultation in regard to such resources will be accomplished for those portions of the remaining 3300 that may be involved." However, it is unclear from your letter whether the Geological Survey has:

(1) Complied with the requirements of Section 2(b) of Executive Order 11593, "Protection and Enhancement of the Cultural Environment" of May 13, 1971, as implemented by the "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800);

(2) Not issued any permit to the Peabody Coal Company for this lease; or,

(3) Issued a coal lease to Peabody Coal Company for the Big Sky Mine without complying with the requirements of Section 2(b) of Executive Order 11593.

Page 2
Mr. Henry W. Coulter
Big Sky Mine
Geological Survey

Therefore, we would appreciate a report clarifying whether or not the Geological Survey has or will take the steps necessary for it to comply with Executive Order 11593 for Coal Lease M-15965 to the Peabody Coal Company. The Geological Survey is reminded that Section 106 of the National Historic Preservation Act (16 U.S.C. 470f), as recently amended (90 Stat. 1320), reinforces the Executive Order and will apply to future leases and development plan approvals.

Should you have any questions or require any assistance with this matter, please contact Brit Allan Storey of our Denver office at P. O. Box 25085, Denver, Colorado 80225, or (303) 234-4946, an FTS number.

Sincerely yours,

Signed

John D. McDermott

John D. McDermott
Director, Office of Review
and Compliance

cc: Mr. Douglas Wheeler, Department of the Interior
Chairman-Clement M. Silvestro
HPO-MT
PR-National Register
DG-STOREY
FILE:MT/BIG SKIES MINES/11593/USGS/Coal Lease
BAS:pab 11-15-76

United States Department of the Interior

XI-56

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

OFFICE OF THE DIRECTOR
In Reply Refer To:
EGS-211083-MS108

OCT 15 1976

Mr. John D. McDermott, Director
Office of Review and Compliance
Advisory Council on Historic Preservation
1522 K Street, N. W.
Washington, D. C. 20005

Dear Mr. McDermott:

We are writing in response to your letter of August 20, 1976, to Deputy Assistant Secretary Wheeler concerning our further consultation with the Council on cultural resources that may be disturbed at the Peabody Coal Company's Big Sky Mine, Montana.

Please be advised that no further Federal action to permit mining of Federal coal beyond section 22, as described in our PES of March 1974, has yet been required or taken. Pages 183-184 of the PES indicates that further studies will be required. As a minimum, before Federal approval for continuation and extension of operations beyond section 22 is given, all requirements for identification, protection, and consultation in regard to such resources will be accomplished for those portions of the remaining 3300 acres that may be involved.

Sincerely yours,

Signed

Acting Director

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Appendix 0-1.-- Scenic quality rating

1. Date
2. Rater
3. State
4. District
5. Plan Unit

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

QUALITY EVALUATION SCORESHEET

6. Recreation Activity

CLASS	SCORE RANGE
7	

BIG SKY MINE

8. KEY FACTORS

9. RATING AREA		10. POINT MAXIMUM								11. TOTAL SCORE	12. CLASS	13. REMARKS
NO. (a)	NAME (b)											
		3	2	1	2	2	1			11	B	

(Instructions on reverse)

Appendix O-2.--Visual Resource Management Rating

The VRM (Visual Resource Management) rating system evaluates scenic quality, visual sensitivity levels and visual zones.

1) Scenery quality ratings are based on the presence of landforms, color, water, vegetation, uniqueness, and intrusions. After rating, the areas are grouped into Class A - 15-24 (Excellent), Class B - 10-14 (Good), or Class C - 1-9 (Average).
2) Visual sensitivity levels are an index (high, medium, or low) of the relative importance of the visual resource. In this case, the only criteria used was numbers of viewers.
3) Visual zones are areas that can be seen as foreground-middleground (3-5 miles from viewpoint), background (5-15 miles from viewpoint), or seldom seen (areas with little or no visibility or beyond the background zones.)

Landscape character elements (form, line, color, and texture) are described because they are the basic factors used to measures changes (or impacts) resulting from the proposed action.

Form - The mass or shape of an object. It is most strongly expressed in the shape of the land surface, usually the result of some type of erosion, but may also be reflected on the shape of the openings, changes in vegetation, or in the structures placed on the land.

Line - Abrupt contrast in form, texture, or color. Lines may be found as ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

Color - Usually most prominent in the vegetation but may be expressed in the soil, rock, water, etc., and may vary with the time of day, year and the weather.

Texture-Result of the size, shape, and placement of parts, their uniformity, and the distance from which they are being obstrued. Texture is usually the result of the vegetation or vegetative patterns on the landscape. Texture may also be the result of the erosive patterns in rocks or soil.

These factors are combined to determine Visual Management classes for which suggested management objectives are prescribed. These classes describe the degree of visual alteration that is acceptable according to Bureau of Land Management standards within the characteristic landscape. Class I provides the greatest amount of protection while Class IV allows for modification of the landscape character.

Appendix O-2.--Visual resource management rating--Continued

Class I (Preservation). This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

Class II (Retention of the landscape character). Changes in and of the basic elements (form, line, color, or texture) caused by an activity should not be evident in the characteristic landscape.

Class III (Partial retention of the landscape character). Changes in any of the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV (Modification of the landscape character). Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape.

Class V (Rehabilitation of enhancement of the landscape). Applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

Detecting contrast (or impacts) in the basic elements varies on a scale from 4 (form) to 1 (texture). Assigning values that indicate degree of contrast (3 for strong, 2 for moderate, and 1 for weak) allows a direct multiplier to be set up which will indicate the strength of the contrast. A score of 1-10 for each feature indicates that the contrast can be seen but does not attract attention; 11-20 attracts attention and begins to dominate the landscape; 21-30 demands attention and will not be overlooked. The total score is not as significant as the score for a single feature. The contrast ratings for the proposed mine are summarized in table 3-1 and 2.

STATE OF MONTANA

DEPARTMENT OF STATE LANDS

MAILING ADDRESS: CAPITOL STATION
OFFICE: 1625 11TH AVENUE
HELENA 59601
(406) 449-2074

RETURN RECEIPT REQUESTED
Certified Mail No. 22097

June 5, 1978

David R. Sturges
PEABODY COAL COMPANY
Regional Counsel
12075 East 45th Street, Suite 203
Denver, Colorado 80239

Re: Peabody's Application 00057 permit

Dear Dave:

The Reclamation Division has reviewed your application for permit submitted 11/15/78. The application is deemed not complete at this time. The Department has detailed the deficiencies with regard to the Montana Strip and Underground Mine Reclamation Act, Title 50, Chapter 10, R.C.M. 1947, and the Strip and Underground Mine Reclamation Rules: Initial Regulatory Program (Emergency Rules).

As stated in Brace Hayden's letter of May 17, correction of deficiencies must be in the form of a complete page which can be inserted into the application.

The following are the deficiencies in Peabody's application #00057:

I. Letter of Transmittal

1. Exhibit "C-2", the 1978 Permit Overlay map shows new areas of affected lands in portions of Sections 26 and 27 T1N, R41E. These areas must be included in the application form and in the narrative.

2. The additional 5.97 acres in the S½ of the S½ of Section 23 must be incorporated into the permit acreage calculations for the application form, Acreage Breakdown, and Breakdown of Bonding Rates - Sections.

II. General Information

3. Page 1, Permit Required by Law. The year of enactment of the Montana Strip and Underground Mine Reclamation Act is 1973 not 1947.

4. Page 1, Location and Affected Lands. The third line of the first paragraph. The word east should be changed to west.

5. Page 1, Location and Affected Lands. This paragraph must include Sections 16 and 27. The scoria pit in Section 27 appears excessively large. This application should include only that scoria needed for a 5 year permit.

6. Page 1, Surface Owners. The names and addresses of the surface owners for Sections 9, 12, 18, and 19, T2N, R41E, must be submitted, and Exhibit "A" revised.

7. Page 2, The annual rainfall and direction and average velocity of the prevailing winds in the area of interest have not been submitted (50-1039 5 (i)).

8. Page 3, Proof of Publication. The area of land affected is listed as being 1263.63 acres in the Application Form. The newspaper announcement lists only the Mining Level disturbance, or 890 acres. The area of land affected also includes areas categorized as Associated Disturbance and Facilities. A new publication is required reflecting these changes.

9. A copy of all authorizations to operate the mine is required at or near the mine site.

10. Postmining Land Use. The Department needs response to the provisions set forth in the Emergency Rule IV (1-4). While addressed on page 20 of the application, further comment is required.

11. Rule IX Signs and Markers. The specific requirements for identification and warning signs and for buffer zone, topsoil stockpile and permit perimeter markers as set forth in Rule IX Subsections (1-6) must be addressed in the application.

12. Prime Farmland. Peabody must demonstrate to the Department using the criteria set forth in Emergency Rule VIII subsections (1-4), whether or not the permit area includes lands defined as prime farmland. If prime farmland is not present, the negative determination(s) must be specified.

Mining and Reclamation Plan

13. Blasting. Each subsection of the Emergency rules, Rule VII, must be addressed with a positive response and/or commitment. While portions have been addressed, all items have not been covered.

14. Page 6, Scheduled Blasting. Production problems are not sufficient reason for unscheduled detonation unless directly related to dangerous atmospheric conditions or public or operation safety.

15. Page 6, Night Blasting. A commitment that blasting will be conducted only during daylight hours is needed. Blasting will not be allowed at night.

16. Page 10, Roads and Railroad Loops. In the first paragraph the definition of "suitable material obtained from the mining pit" must be clarified. The Department is also interested in the approximate cubic yards of material that are needed for haulageway subgrade.

17. Page 10, Haulageway Road Location. The word "should" in the second sentence, must be changed to "will".

18. Page 11, Access Roads. The word "haulage" in the first paragraph, second sentence, must be changed to "access".

19. Page 11, Drainage Ditches. Include "water will be intercepted before reaching a large fill and will be drained off or released below the fill".

20. Page 12, Dust Abatement. What are the chemical dust suppressants being used on an experimental basis?

21. Page 12, Completion of Operation. Where will the road surface material be disposed of? Subgrade material?

22. Mining Method. Page 13, at the bottom of the page, a reference is made to the creation of "surface irregularities" in the grading of spoils. These proposed features will require a detailed description before approval by the Department.

23. Backfilling and Grading 1(c). Peabody must submit accurate slope measurements as specified in this subsection to determine the slopes of the area before mining. Depressions will not be allowed in final grading in order to substitute for construction of lower grades. Additionally, evaluation of depression contours suggests they will create a hazard due to the excessively steep slopes.

24. Backfilling and Grading 1(c)(i)(B). Peabody must commit to the slope measurements that are required after final backfilling and grading.

25. Backfilling and Grading 1(c)(ii). A statement that final graded slopes will not exceed the approximate premining slopes or any lessor slope specified by the Department is needed.

26. Backfilling and Grading 1(d). A commitment that any terrace installation will be approved in writing beforehand by the Department is necessary. Additional surface manipulation procedures shall be installed as required by the Department.

27. Backfilling and Grading 1(e). Peabody must justify the use of small depressions in the final backfilling and grading plan and demonstrate a higher or better use than that which occurred prior to mining. If the Department determines at any time that a permanent impoundment will not fill to expected levels, meet acceptable water quality standards or any other criteria, the impoundment area shall be regraded and surface drainage facilitated Rule V (12). The holding capacities of the proposed depressions shown in "Exhibit F" must be given along with appropriate data addressing possible impacts on the hydrologic balance. The Department cannot approve holding capacities for depressions greater than 1 cubic yard of water unless Peabody demonstrates that the proposed depression is needed, does not restrict normal access, does not create a hazard and is compatible with the intended postmining land use. In addition, Peabody must demonstrate that inflow to the proposed ponds will exceed evaporation and that water quality will be suitable for the long-term intended use of the pond.

28. Backfilling and Grading 1(f). All permanent impoundments proposed must address the requirements of Emergency Rule V Hydrology (12) and subchapter S10310 relating to grading.

29. Backfilling and Grading 1(g). Detailed response and commitment to this subsection on burial of acid forming, toxic, combustible or otherwise undesirable materials and covering of exposed coal seams is required. Acid forming or toxic forming material shall not be buried or stored in proximity to a drainage course so as to cause or pose a threat of water pollution.

30. Page 16, Material Placement. A commitment to bury materials not conducive to revegetation techniques, establishment, and growth at least 8 feet below the surface of regraded spoils or other affected areas must be made (S10310(1)(h)). See page 30 for a detailed discussion of additional requirements relative to the overburden and innerburden.

31. Backfilling and Grading. A determination of whether or not Peabody meets the thick overburden requirements of S10310 (1)(k) Emergency Rules is necessary.

32. Grading Along the Contour. S10310 2(c) must be addressed in detail.

33. Regrading or Stabilizing Rills and Gullies. S10310 2(d) must be addressed in detail.

34. Buffer Zones S10310 (3). Buffer zone limits must be shown on the submitted maps.

35. Pages 16, and 17, Final Graded Condition. The detail and accuracy of the Postmining Contour Map (Exhibit F) is not acceptable. Peabody must tie in all regraded contours with the existing topography and provide a way to distinguish between reclamation contours and native ground.

36. Page 17, Grading Timetable. The clause, "In the event augering and stripping are used, the augering shall follow the stripping by not more than 60 days and the final grading and backfillings shall follow the augering by not more than 15 days", must be added.

37. Page 17, Grading Timbetable. The clause, "All backfilling and grading will be completed within 90 days after the Department has determined that work has been completed or a prolonged work suspension in the area will occur", must be added.

38. Page 18, Reduction Requirements. Impoundments of water, if approved, are not exempt from the maximum allowable slope requirements. Slopes on the postmining contour map show impoundments at 2:1. The Department will not approve any impoundment where it poses a safety hazard or otherwise conflicts with the postmining land use. The postmining contour map will need revision to meet a 5:1 slope requirement unless otherwise approved. (See S10310 1(e) and (f)).

39. Page 18, Reduction Plan and Buffer Zones. Buffer zones must be used <u>around</u> not <u>on</u> unminable, steep or precipitous terrain. The application should contain a mining plan overlay to be used with the aerial photograph since it is not difficult to accurately relate the mining disturbance with the existing topography. The mining plan should show the individual cuts in the areas to be mined as well as the proposed location of initial spoiling.

41. Page 20. The paragraphs addressing S10350(1) must be reworded to better address the rules and the act. Peabody must commit to establishing a suitable, permanenet, effective, and diverse vegetative cover of species native to the area of disturbed

land or species that will be capable of meeting the criteria set forth in Section 50-1045 on all areas of land affected except travelled portions of railroad loops and roadways or areas of authorized water confinement.

42. If prime farmland is involved, S10350(2) should be addressed.

43. S10350(3) should be addressed with a commitment.

44. Page 21. Seed mixture. Witmar beardless wheatgrass is Agropyron inerme not Agropyron trachycaulum.

45. Page 22. Seed mixture. The rate is suited to drill seeding; if Peabody is going to continue broadcast seeding the rate should be increased. The alfalfa and yellow sweet clover rates should be reduced to 1/2 lb. per acre. Present reclamation tends to be dominated by yellow sweet clover and alfalfa.

46. Page 22. Relying on natural reinvasion by forbs is unacceptable. This method does not guarantee the reestablishment of forbs nor does it provide any control over the species. Peabody must institute a seeding program and if necessary a seed development program for forbs.

47. Page 22. The paragraph on tree and shrub reestablishment is unacceptable. Peabody must institute a program which assures the availability of certain species and the number of these species. The law requires that the reclaimed vegetative cover is capable of feeding the quantity and mixture of wildlife comparable to that which the area could have sustained prior to mining. If sufficient shrub growth is not present, Peabody's bond will not be released. (Note: Caragana and Russian Olive are not native).

48. Page 22. Peabody's present method of seeding has not been satisfactory to the Department. On at least two occasions poor vegetative stands have been attributed to the seed being washed away (conversations with Gene Tuma). The Department understands that Peabody has purchased a cultipacker. If used in conjunction with the Ezee flow seeder the cultipacker should improve seeding results. The drill should be more reliable in establishing a vegetative stand and should be given consideration for wider scale use.

49. A temporary cover crop must be seeded on all disturbed areas.

50. A commitment is needed in the application stating that: "when rills or gullies deeper than nine inches form in areas that have been graded and topsoil replaced but vegetation has not yet been established, Peabody shall fill, grade or otherwise stabilize the rilss and gullies and reseed or replant the areas."

51. A commitment is needed that all seeding will be done on the contour. Even if broadcast seeding is used, vehicle tracks perpendicular to the slope encourage erosion.

52. Mulch must be applied to all slopes greater than 10:1. On slopes of less than 10:1 the use of cover crops alone should be sufficient to prevent erosion.

53. Reclamation Plan. Page 23. It is stated that "soil amendments will not be applied unless research and plant growth indicate they are necessary. . ." What research, if any, is being referred to? Does Peabody have any experience which could throw some light on this area?

54. Page 24. In addition to fencing, Peabody must commit to prevent livestock grazing until the seedlings are established and can sustain managed grazing.

55. Page 24. At this time the Department has not determined whether or not a grazing program will be required, but wishes to keep that option opened.

56. Vegetation control areas as outlined in the forthcoming rules and presently described in the guidelines should be addressed.

57. Vol. 1 - Maps. (a) Exhibit "C-1", Combined Permit Map, has a section corner mislabeled. It should read:

$\frac{15\ 14}{22\ 23}$ instead of $\frac{15\ 14}{23\ 24}$.

III. Vegetation Study

The vegetation has not been mapped for all of the proposed permit area. The vegetation on all areas in the proposed permit area must be mapped including areas of associated disturbance and facilities.

The sampling is inadequate. There were no samples in the majority of the application area. Sampling should be spread throughout the area, and throughout the types, proportional to the size of the type. The variation between the 1976 and 1977 data, and between the type names, the narrative, and the tables indicates a need for more sampling. It was unclear how many different transects were run in each type between the 1976 and 1977 reports. One, two, or even three transects do not yield sufficient data to adequately describe the vegetation communities in the area. More transects are needed in all types spread throughout the area.

A comparison of the narratives and the data tables in the 1977 report indicates a need for more sampling, and possibly splitting the area into more types:

For example:

Type	Title	Comment
111.3	Agsm-kocr Stco	Prairie junegrass was listed in the title but was not found on the transect.
111.3(Y)	Agsm-kocr Stco	Same comment
111.4	Calo-Ansc-Ange	Needle and thread grass shared dominance but is not listed in the title.
211/212.2	Artr-Agsm-Kocr/Arca-Agsm-Kocr	Bluebunch wheatgrass present in high amounts but not listed in the title.

The narratives for the 1976 and 1977 reports do not mesh very well. The variations indicate a need for more sampling and again possibly splitting the types into two or more types. It appears in some instances that three species are used to broaden a type rather than make it more specific. The types appear to describe range sites rather than vegetation types. Specific data for discreet types are needed to describe the premining area in order to facilitate bond release determination.

A new report should be submitted summarizing the data gathered to date, and incorporating the new data required to satisfy the previously mentioned problems. Peabody should immediately get in touch with Dennis Hemmer, the Department of State Land's vegetation analyst before doing additional work in order to assure that such work satisfies the Department's requirements.

IV. Groundwater Hydrology

1. Observation Well System. Data need to be provided which indicate that clinker is not a potential groundwater source. Is the clinker an important groundwater recharge area? To what aquifer(s)? Is it a source of local recharge to deeper aquifers?

2. Site Specific Aquifer Characteristics. Pump test discharge is not in cfs, it is in cubic feet/min. Present data and calculations used to arrive at transmissivity values.

3. Groundwater Occurrence. Alluvium aquifers - "thin non-continuous infrequently recharged by snowmelt and thunderstorm runoff". Exhibit Q shows water level contour map over a 1 square mile area. The map indicates the alluvial aquifer is fairly continuous which does not agree with the statement "finite dimensions of these aquifers precludes the possibility of the system providing an adequate groundwater source". Data must be included to support this statement.

4. Groundwater Flow and Recharge Aquifer Characteristics. Exhibit P All data points used to construct the water level contours must be shown clearly. Explain how the recharge and discharge areas were determined.

5. Overburden Aquifer. Explain how the hydrographs indicate that "water does not freely percolate to recharge deeper aquifers". The relatively static nature of the water levels as shown by the hydrographs may indicate a fairly long flow system. "Static hydrologic system" must be explained in further detail.

6. Rosebud Aquifer. Provide data of the 7 in-field tests conducted to estimate the amount of water that the Rosebud will contribute to the active pit.

7. Rosebud Spoil Well Hydrographs. The hydrographs do not agree with the statement that "the water table fluctuations appear to be in response to annual climatic conditions with primary recharge occurring during the spring with groundwater declines being monitored during the dry summer months". The hydrographs need to be correlated with the precipitation records to determine if local recharge occurs. Water level declines appear to occur in the spring with water level rises in the fall.

All data points used in construction of the water level contour map to determine direction of groundwater flow must be clearly shown on the contour map to indicate whether there are enough data to draw all the equipotential lines that have been drawn.

8. McKay Aquifer. Figure 26 (well #13-S, 1973) Explain what caused the water level decline in November. A 9.4 foot decline within 2 months of installation of the well. Explain water level rise. Recharge from pit?

9. Sub-McKay Sandstone. Explain possible reasons for water level rises. List any alternative possibilities.

10. Coal Bank Coulee and Sub-irrigation Hydrology. Geologic, and geologic structure maps of the area surrounding Snider's alfalfa field should be submitted. The source of water subirrigating Snider's field has not been determined. Include all geologic data that are available. Include data on the anticlinal structure in the area.

    Data must be presented which indicate that groundwater discharge from the McKay coal and overlying strata directly to the residual soils, aluvium, etc. of Snider's field is not a source of sub-irrigating water. Or does the water recharge the sub-McKay sandstone beds (present data)? The water level data for alluvium wells #11, #12, #13 and #14 should be correlated to precipitation events. What effect will recharge from the reclaimed areas have on sub-irrigation to Snider's field? Rising water levels in the sub-McKay sandstones may increase sub-irrigation and may lower the quality of the sub-irrigating waters.

    Progress Report - Hydrologic research at the Big Sky Mine - Page 18.

    With regards to this report, were additional neutron access tubes plus and observation well installed in the northern portion of Snider's field in the spring of 1977 as indicated on page 18? Identify these holes in the permit application data or include this data if it was not made available to the Department.

11. Hydrologeology - Conditions with Future Mining. (a) The statement about vertical hydraulic conductivities must be backed by data. Did pump test data indicate low hydraulic connection between aquifers?

(b) Present data which indicate that those wells and springs to be affected will be located within 0.5 miles of the mine area.

(c) Will spoils produced by mining have greater vertical hydraulic conductivities than alluvial aquifers? Present data to indicate this. What effect will increased vertical hydraulic conductivity have on the waters level in undisturbed aquifers adjacent to the reclaimed areas.

12. Future Groundwater Flow. "Effluents from Miller Coulee box-cut operations are pumped into sediment ponds in Miller Coulee or into the Department of Natural Resources' impoundments and from there enters the shallow groundwater system." What effect does this have on groundwater quality in this system.

13. Alluvial Valley Floors. More data must be presented to make a determination as to whether or not alluvial valley floors are present at Peabody.

14. Summary. "Annual precipitation is about 15.8 inches." In the section under Hydrometeorology - "annual precipitation at the Big Sky lease area is 14.9 inches." "During 1974, the aquifers received little or no recharge. In 1975, and again in 1976, as much as 12 inches of recharge entered shallow, undisturbed aquifers at some location". Explain how 12 inches of recharge occurred with 15 inches of precipitation, and why there was no recharge in 1974. How was the amount of recharge determined?

15. Questions arise concerning observation wells #BS-01 and BS-02, both in sandstone below the McKay coal bed. BS-01 is 220 feet deep--154 feet (depth to water), BS-02 is 108 feet deep--44.15 (depth to water). Why the great difference in depth to water in the 2 wells?

16. Wells and springs in Table 6 must be numbered.

17. Peabody shall commit to restore the approximate pre-mining groundwater recharge capacity of the reclaimed areas as a whole. Peabody shall continue to monitor, and present data which indicate the approximate recharge capacity has been restored.

    Peabody shall commit to placing all backfilled materials so as to minimize adverse effects on groundwater flow and quality, to minimize off-site effects, and to support the approved postmining land use. Peabody shall continue to monitor the effects of mining and submit data to indicate the above provisions have been met.

Peabody shall commit to replace the water supply of an owner whose supply has been affected by mining.

V. Surface Water Hydrology

Vol. 1, p. 12. Peabody states, "Upon abandonment of any road or railroad. . . the surface material will be removed and disposed of, buried or reused if possible. Culverts and drainage structures which were necessary during the use of the road will remain if it is determined that this would help the drainage situation and prevent possible sedimentation problems, otherwise the structures will be removed and the drainage systems returned to their approximate original condition."

The Department requires that all final grading within the area of land affected must be graded to the approximate original contour as required under S10310 (1)(b). Clearly, grading to the approximate original contour requires that all roads, railroad loops and access roads be removed or regraded to blend into the regraded or existing topography and complement the existing drainage pattern.

Therefore, Peabody must commit to removing or regrading the entire cut or fill associated with haul roads, access roads or railroad loops to blend smoothly with the regraded or existing topography. In addition regraded slopes associated with railroad or raod grades must be no steeper than the premining slopes, in order to be in compliance with the approximate original contour provisions.

Vol. 1, p. 16 completion of operations. The Department cannot accept the scheme outlined by Peabody regarding opening of the box-cut, spoil storage and subsequent backfilling as mining progresses.

The interim revised regulations state under S10310 (1)(b), that "All final grading on the area of land affected shall be to the approximate original contour of the land. The final surface of the restored area need not necessarily have the exact elevations of the original ground surface. Where a flat surface or a surface with less slope than the original ground surface is desired, such surface shall be deemed to comply with backfilling and grading to the approximate original contour."

S10310 (1)(c)(ii) "Final graded slopes. The final graded slopes shall not exceed either the approximate premining slopes . . . or any lessor slopes specified by the regulatory authority. . ."

S10310 (1)(1) "Box cut spoils or portions thereof, shall be hauled to the final cut if:

(i) eccessively large areas of the mine perimeter will be disturbed by proposed methods for highwall reduction or regrading of box cut spoils; or

(ii) material shortages in the area of the final highwall or spoil excess in the area of the box cut are likely to preclude effective recontouring".

In addition, approximate original contour "means that surface configuration achieved by backfilling and grading of the mined area so that the reclaimed area. . . blends into and complements the drainage pattern of the surrounding terrain, with all highwalls and spoil piles eliminated. . ."

S10310 (3)(b) "The transition from undisturbed ground shall be blended with cut or fill to provide a smooth transition in topography".

Based on these compiled regulations the Department makes the following requirements regarding Peabody's revised mining application that will result from this letter.

1. The postmining topography will closely resemble the premining surface with no regraded slopes steeper than the premining slope. This precludes the leaving of box cut spoils on top of otherwise undisturbed ground as well as forming spoil storage areas where the spoil mound would have greater elevation or volume then the premining surface configuration.

2. The final location of the pit will be backfilled with box cut spoils or excess spoil. Excess spoil is considered to be material that results from the mining of a steep slope or a high overburden area where lessor slopes would be desirable from a reclamation erosion stability viewpoint. The Department discourages disrupting areas that would otherwise remain undisturbed in order to obtain sufficient material to backfill the pit.

3. The regraded surface must provide a smooth transition with the undisturbed ground. Backfilling and grading should be the primary technique used to provide the smooth transition. Only rarely under sound planning will the Department approve cutting of undisturbed ground to achieve a smooth transition.

4. The regraded surface will complement the existing drainage pattern. All concentrated drainage will be carried onto and across the regraded surface in channels with similar configurations to the original situation. All stream gradients will have to be maintained at slopes no steeper than those existing prior to mining, the gradients should be smoothed out to achieve a concave longitudinal profile through the regraded area with no mining related oversteepened sections (nick points i.e. where the profile changes from concave to convex).

The Department expects that drainages will be accurately designed and carefully constructed during the regraded phase of the operation. Peabody should have as their objective in designing postmining drainage channels, to achieve the greatest degree of stability possible for the area without using artificial erosion constraints. Since nature has developed a dynamic equilibrium for the drainages, through erosion over geologic time, it is expected that the existing drainage channel dimensions would provide the best design for Peabody to utilize in their reclamation planning.

There will be situations where backfilling into steep high overburden areas will preclude effective reclamation. If reclaimed drainage channels were restored to the steep gradients that existed prior to mining, over rocky substrates, the spoil material would be severely eroded. The Department has recently concluded that 3:1 reduced highwall slopes involve a large risk as to whether these slopes can ever be stabilized and has been requiring highwall reduction to a 5:1 slope with few exceptions. Therefore, when mining into steep areas where drainage channels can not effectively be restored or where highwall reduction to a 5:1 would involve disturbance of large areas above the highwall. Peabody should either mine through the headwaters of these areas or cease mining back from the precipitous topography to a point where backfilling can effecitvely restore drainages and slopes.

The Department will only consider highwall reduction in areas not involving concentrated drainage over the highwall or where such drainage is over a competent bedrock and where the grading will not disturb excessive areas above the highwall. Spoil not required to achieve the approximate original contour can be treated under Rule VI Disposal of Spoil.

5. Peabody must compare the textures of coulee bottom materials pre- and post-mining in relation to relative erodibility. The Chinook and Tullock fine sandy loams, for example, would not be a suitable soil series to be used along drainage bottoms.

6. Peabody must keep all disturbance associated with highwall reduction within the mining level disturbance area. The current postmining topography map shows highwall reduction outside the area bonded for mining level disturbance in the NE¼ of Section 14.

7. P. 16 - Selected Materials Burial (S10310) (1C) An uneven settling of spoil materials resulting in the formation of a depression has occurred at the Big Sky Mine. Presumably the rapid settling is the result of an accumulation of biodegradable materials that were buried in the pit. Peabody should address how this situation will be avoided in future mining areas.

8. P. 17 - Grading timetable. The Department may allow delayed grading of box cut spoils if better recontouring will result S10310 (1)(m)(i).

9. Peabody must demonstrate the surface stability of the reclaimed area after mining in order to qualify bond release. Peabody must present the method that will be used to document the surface stability of slopes and drainage bottoms. Consideration should be given to sediment being produced from slopes and sediment yield from the basin in comparison to normal levels.

Volume 6 - Surface Hydrology - Surface Water Methodology.

1. The Department feels that the precipitation runoff relationship is an aspect of the hydrologic system which may be affected by mining. Peabody states that continuous water level recorders, located on the spillways of the major impoundments, will monitor effluent discharge rates with data ultimately being used to evaluate precipitation/runoff events. Peabody should detail how they are going to evaluate the precipitation runoff relationship without knowing the amount of water stored in the impoundment prior to the precipitation event?

2. Peak Flows. The Department requests that Peabody show all calculations for determining peak flow values, including nomograph readings, areal correction factors, runoff coefficients, etc. Peabody should reference the source of the runoff rate used as .09 inches per year. Peabody has selected the 10 year - 24 hour precipitation event and flow resulting from that event for design of ditches and dams. The probability of an event occurring during the seven year mine life that will equal or exceed the 10 year event is .52. The Department would prefer a proability of failure to be less than .4. This would dictate a ditch design, capable of handling the 15 year peak runoff event.

3. Flow velocities. The Department would like Peabody to detail any drainage areas that have been flagged for potential erosion problems. If such areas exist the channel dimensions at that location should be altered on the postmining topography.

4. Miller Coulee Diversions and Impoundments. The Department requests that Peabody update information regarding the Miller Coulee diversion and impoundment system.

   (a) Was flow from upper Miller Coulee passed through the diversion this spirng?

   (b) Describe any erosional problems that may have occurred and how this might relate to future design considerations.

5. The design calculations for all dams, spillways and ditches should be included in the application. Consideration should be given to velocitites in the ditches as it relates to the capability to transport bed and bank materials. Spillways should be designed to handle at least the peaks flow for the fifty year recurrence event.

6. Peabody Coal Company should commit to a water monitoring scheme at discharge points as follows:

   a) The following monthly water samples from impounding structures should be analyzed for:

   1) Oil and grease
   2) S.A.R.
   3) Conductivity
   4) pH
   5) Total iron
   6) Total manganese
   7) Total suspended solids
   8) $NO_3 + NO_2$ as total N
   9) Ammonia nitrogen
   10) Total kjeldahl nitrogen

   b) Quarterly (the first week of June, September, December, and March) Total analyses as specified in the Montana Department of State Lands Water Resource Guidelines, p. 18.

   c) Weekly samples will be taken and analyzed in number 1 above during periods of discharge.

   d) A record of all water pumped from the pit must be accurately kept. The Department suggests a flow metering system such as the one in use at the Big Sky Mine which was developed by the Billings office of the Montana Bureau of Mines and Geology. If water is to be directly removed from the pit and applied to roads, an automatic traffic counter (approved by the Department) shall be used to keep track of the number of loads of water removed. Weekly summaries shall be collected and submitted to the Department with the capacity of the water trucks specified so the total number of gallons removed from the pit can be calculated.

   e) All water data should be submitted to the Department within 60 days of sample collection. Yearly summaries of water data should be submitted including a graphical display of the year's data with the annual report that is due within 30 days of the anniversary date of each permit.

Interim Regulations

Peabody Coal Company should provide a thorough response to Emergency Rule number V detailing all calculations, justification for all actions and commitments to all conditions required of a mining company. It is recommended that Peabody provide such information in an easy to follow format to facilitate rapid permit review. The Department prefers that the text of the regulation be provided side by side on a split page with the response to the regulation.

VI. Soils

Volume VI - Appendix 7.

1. The soil survey section was very poorly organized and downright erroneous and thus very difficult to comprehend.

2. Page 7 - C1 horizon description includes a description of porcelainite fragments of 50 to 20 percent? Please clarfy.

3. Page 8 - What are "lithie heploboralls"? It appears that that sloppy typographical errors are responsible. Also, the second sentence states that "Removal layer for stripping (of Ringling series) is between 4 to 5 inches." On the other hand, the last paragraph states this soil is not suitable for stockpiling. to salvage or not to salvage-that is the question.

4. Pages 8, 10, and 11 include descriptions of mapping units that may have included highly contrasting soils of up to 5 acres in size. If so, these highly contrasting inclusions should have been mapped out pursuant to current soils guidelines of the Department of State Lands. A similar consideration applies to included soils in mapping unit 700 - page 15.

5. The map locations of the typifying pedon descriptions of Ringling, Lambeth, and Tullock series were not stated. In addition a minimum of two profiles for each series should be described and should be the same profiles from which samples are taken for analysis.

6. Pages 10 and 11 were reversed in the sequence they should have been in.

7. Page 17 - The description of the location of sample 13 for the Chinook series does not match its map location on Exhibit H.

8. Although submitted in a report associated with a previous permit, analytical data for pB #16, 17, 18, 19, and 20 could easily have been submitted by Peabody in the present permit application to make the information more coherent and readable.

9. Several discrepancies were noted between Ec (electrical conductivity) and the sum of the cations, the most significant of which was the last two horizons of pB #17 and 18 (old submitted data).

10. Incorrect textural designations were noted for the 2nd horizon of pB #13, last horizon of pB #14, and the 2nd horizon of pB #20.

11. The changes in the mapping units and legend that were indicated in a July 1975 submittal entitled "Appendix 3, 1974 - 75, Descriptions of Soil Series for Peabody Coal Company, Revision of and Supplement of Soil Types" have not been made in the present application. Mapping units 200 and 600 should be deleted from the text and the map, including the legend. The description of mapping unit 500 and the name of unit 300 should be changed appropriately.

12. On page 31, Peabody refers in hazardous levels of borons in terms of milligrams/liter, the Department of State Lands suspect level is in relation to ppm of dry soil. If Peabody determined boron in terms of mg/1 (of extract?), then the data were gathered incorrectly.

The following apply specifically to the soils map:

13. Paralleling the western border of Section 14 and starting in the SW corner of Section 14 is a unit mapped as Alluvial Soils (400) that ends abruptly and becomes Yawdim - Rock Outcrop Association (300), although the latter contains significant portions of the remainder of the coulee mapped farther south as Alluvial soils. The same situation exists in a more gross fashion in the middle of Section 15. This appears to be, at best, incorrect.

14. Southeast of the middle of Section 15 one mapping unit has two numbered designations - 300 and 400. This situation recurrs north and east of the SW corner of Section 15 where the numbers 1002 and 900 exist in the same unit.

15. An undesignated unit occurs 1000 feet north and 400 feet west of the SE corner Section 15.

16. South and west of the middle of Section 14 a unit designated 1001 includes a coulee which is mapped on the north and south sides of this unit as Alluvial soils (400). Why has the coulee not been mapped out in this unit?

17. In Section 13, why has the major coulee here been mapped as McRae Loam (900) and not Alluvial soils (400), whereas the reverse is true elsewhere?

18. In Section 22, some lines on the map have been erased. These need to be redrawn.

19. Problems noted by Walt Swain of the Northern Powder River Basin EIS team in the form of a memo to Neil Harrington are attached to this letter.

20. All of these problems need to be addressed. Specific questions and comments by Peabody should be directed to Neil Harrington.

VII. Overburden

Volume VI - Appendix 8.

1. Conductivity (EC) measurements were based on which method - saturation extracts or 1:5 extracts?

2. Table U-1 - What is "ammonium ovulate"?

3. A problem not addressed by Peabody with regard to the innerburden, the overburden immediately above the Rosebud seam and the overburden of varying thickness above the McKay seam where the Rosebud does not exist is the extremely elevated levels of molybdenum in these layers. This is potentially a serious problem with respect to postmining plant accumulation of this element and the resultant Cu: Mo imbalance that can occur in grazing animals. (For example, see Erdman, James A. et al., Jan., 1978, Molybdenosis: A Potential Problem in Ruminants Grazing on Coal Mine Spoils. J. of Range Mgt: 34 - 37). In addition, several samples in the second table of the regraded Spoils data (Appendix 8-6) exhibited elevated Mo. Further evaluation of this problem will be required and this will include the analysis of regraded spoils samples for Mo and sampling of reestablished vegetation for Mo and Cu analysis. Baseline information on the Cu and Mo status of undisturbed vegetation should be gathered from existing literature sources and from an analysis of samples of undisturbed vegetation from the proposed permit area. Peabody shall submit a plan addressing these activities. In lieu of information to the contrary with regard to this problem, Peabody shall address in detail as a part of this permit application the burial of the above problem materials below 8 feet of the surface and above the top of the McKay Coal seam.

4. In the section on regraded spoils data, what thicknesses of topsoil and spoils do these samples represent?

Appendix 8-7.

5. It does not appear that mining pursuant to exhibit V-2 effects burial of the parting material, nor does it appear that any of the methods exhibited, effect isolation of the parting above the McKay seam zone. On the other hand, the narrative for exhibit V-1 indicates that the parting will in fact be isolated above the McKay seam zone. These discrepancies need to be cleared up and the schematic drainings and narrative must show how burial will be effected pursuant to item 3 above.

6. Please submit data on clay minerology of the parting material that was referred to in the text.

VIII. <u>Topsoiling</u>

1. Page 18, Topsoil Salvage and Redistribution. In the first sentence, "recoverable" must be changed to "all available".

2. Page 19, Topsoil Salvage and Redistribution. What equipment, other than scrapers, as listed in the application, will be used for topsoil salvage and redistribution?

3. Page 19, Topsoil Storage Maintenance. In the third sentence insert the word "contamination".

4. Page 19, Topsoil Storage Maintenance. A commitment that topsoil stockpiles will be seeded immediately must be included.

5. Page 19, Maintenance of Replaced Topsoil. The requirement that stockpiled topsoil will be replaced on all areas to be seeded within a 90 day period prior to revegetative seeding or planting must be included.

6. Pursuant to S10340 (1), Emergency Rules, Peabody shall commit to a "two lift" topsoil salvage operation, i.e., salvaging, storing and redistribution, in order to segregate the "A" horizon material and the "B" horizon organic material, from the rest of the topsoil. The "A" and "B organic" lift shall be <u>stockpiled</u> separately from the other salvaged topsoil. To the extent possible, topsoil shall be redistributed immediately according to the requirements of paragraphs 4, 5, and 7 of this section. These commitments must be included in the application.

7. If the removal of topsoil results in erosion that may cause air or water pollution, the size of the area from which the topsoil is removed shall be limited and methods of erosion abatement approved by the Department will be indicated pursuant to S10340 (3).

8. A commitment that Peabody will take all measurements necessary to assure the stability of topsoil on graded spoil piles is needed pursuant to S10340 (7).

9. Although topsoil substitutes are not proposed at this time, a commitment to the provisions of S10340 (8) must be included in the event unforseeable circumstances necessitate the use of material other than topsoil.

VIII. Air Quality

The Department will evaluate in consultation with the Air Quality Bureau current air monitoring sites in relation to the proposed mine site to determine if the current scheme is adequate.

IX. Coal Conservation Act

The information provided in Peabody's application is insufficient to adequately determine if the provisions of the Coal Conservation Act are being met. Peabody should contact George Hurlburt at the Department of State Lands to coordinate what further information is needed.

Please write or call as questions arise regarding these application deficiencies.

Sincerely,

Richard L. Juntunen, Chief
Coal Bureau
Reclamation Division

c: Brace Hayden
Leo Berry, Jr.
Bob Yuhnke
Greg Mills
Doug Hileman
Dave Stiller

lw

English-Metric Conversion Factors

To convert English unit	Multiply by	To obtain Metric unit
Inches (in)	2.54	Centimeters (cm).
Feet (ft)	3.048×10^{1}	Centimeters (cm).
	3.048×10^{-1}	Meters (m).
Miles (mi)	1.609	Kilometers (km).
Square feet (ft^2)	9.290×10^{-2}	Square meters (m^2).
Acres	4.047×10^{-1}	Hectares (ha).
	4.047×10^{-3}	Square kilometers (km^2).
Acre-feet (acre-ft)	1.233×10^{3}	Cubic meters (m^3).
	1.233×10^{-3}	Cubic hectometers (hm^3).
Cubic yards (yd^3)	7.646×10^{-1}	Cubic meters (m^3).
Pounds (lb)	4.536×10^{-1}	Kilograms (kg).
Short tons (tons)	9.072×10^{-1}	Metric tons (t).
Pounds per acre (lb/acre)	4.883	Kilograms per hectare (kg/ha).
Btu/lb	2.326	Kilojoules per kilogram (kJ/kg).
Gallons (gal)	3.785×10^{-3}	Cubic meters (m^3).
Gallons per minute (gal/min)	6.309×10^{-2}	Liters per second (L/s).
Degrees Fahrenheit (°F)	([1])	Degrees Celsius (°C).

[1]Temperature in °C =(temperature in °F − 32)/1.8.